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(54) **SYSTEMS AND METHODS FOR DETERMINING STATUS OF SENSORS**

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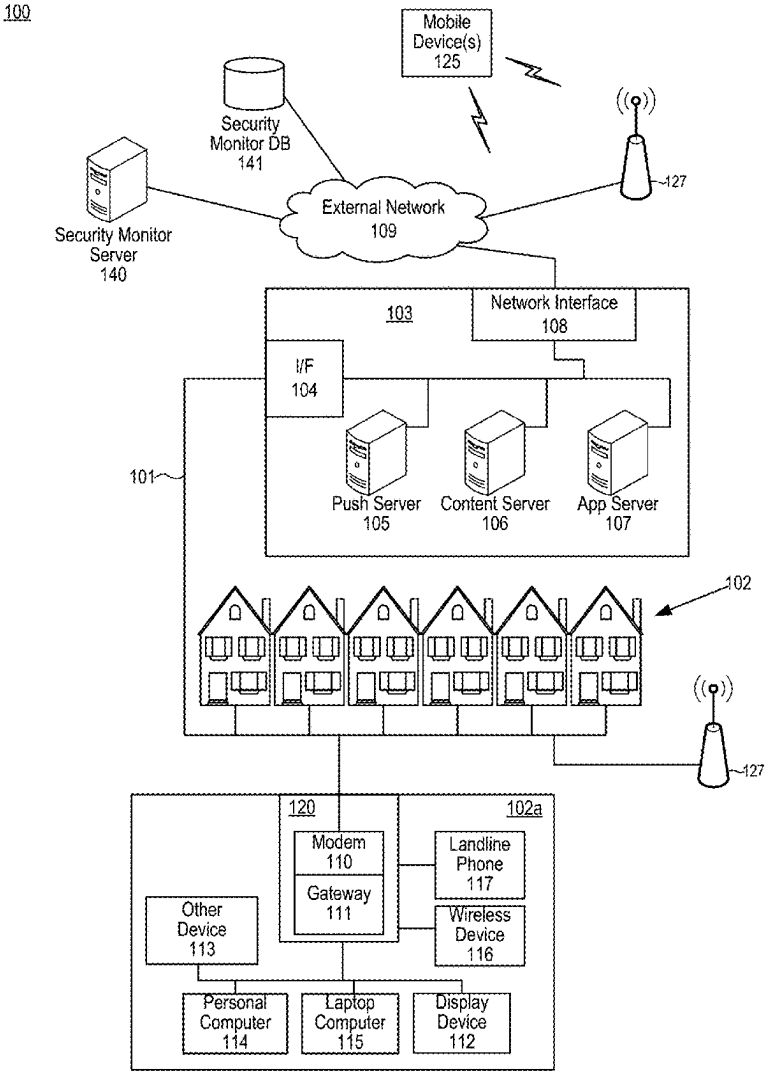
(57) **ABSTRACT**

Systems, apparatuses, and methods are described for monitoring objects. A sensor positioned on an object (e.g., a door) is configured to measure a strength of a magnetic field of a magnet positioned on an associated object (e.g., the door frame). The measurements of the strength of the magnetic field made by the sensor may change over time (e.g., may decrease) due to changes in the positioning or alignment of the sensor or magnet. The positioning or alignment of the sensor or magnet may change due to use of the object (e.g., use of the door). One or more thresholds used by the sensor to determine the status of an object (e.g., to determine whether the door is open or closed) may be adjusted based on changes to the measurements over time.



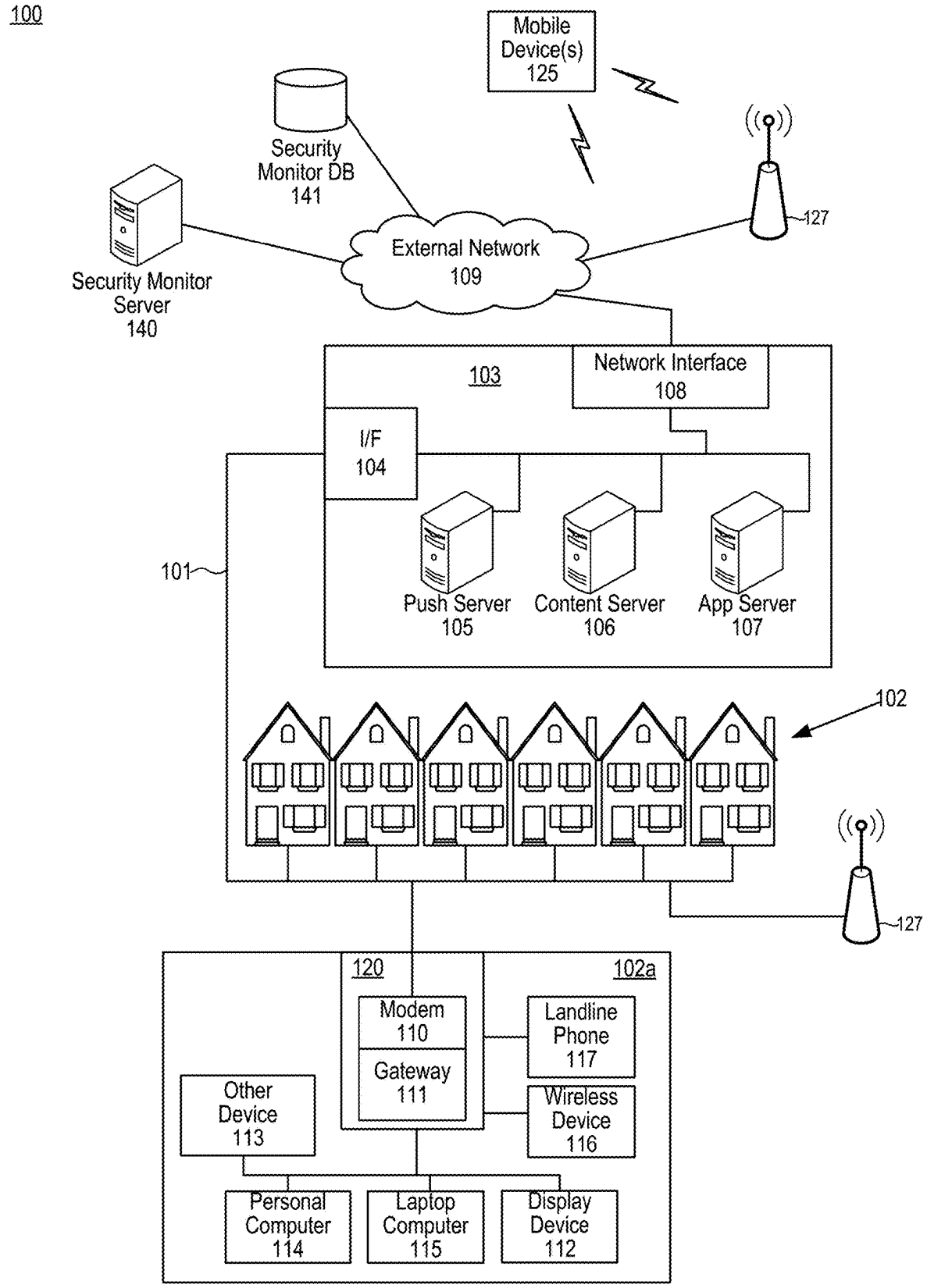

100
Mobile Device(s) 125
Security Monitor DB 141
Security Monitor Server 140
External Network 109
127
103
Network Interface 108
I/F 104
101
Push Server 105
Content Server 106
App Server 107
102
127
120
102a
Modem 110
Gateway 111
Landline Phone 117
Wireless Device 116
Other Device 113
Personal Computer 114
Laptop Computer 115
Display Device 112

FIG. 1

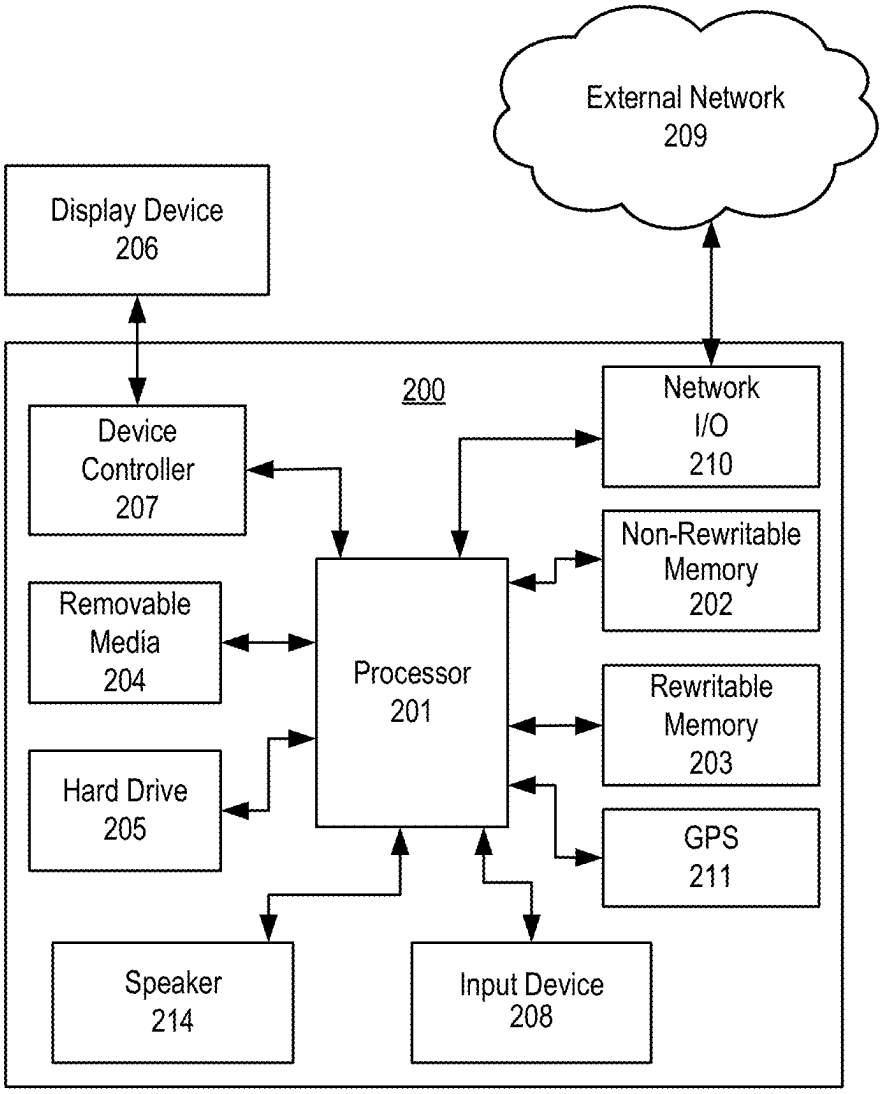

External Network
209
Display Device
206
200
Device
Controller
207
Network
I/O
210
Non-Rewritable
Memory
202
Removable
Media
204
Processor
201
Rewritable
Memory
203
Hard Drive
205
GPS
211
Speaker
214
Input Device
208

FIG. 2

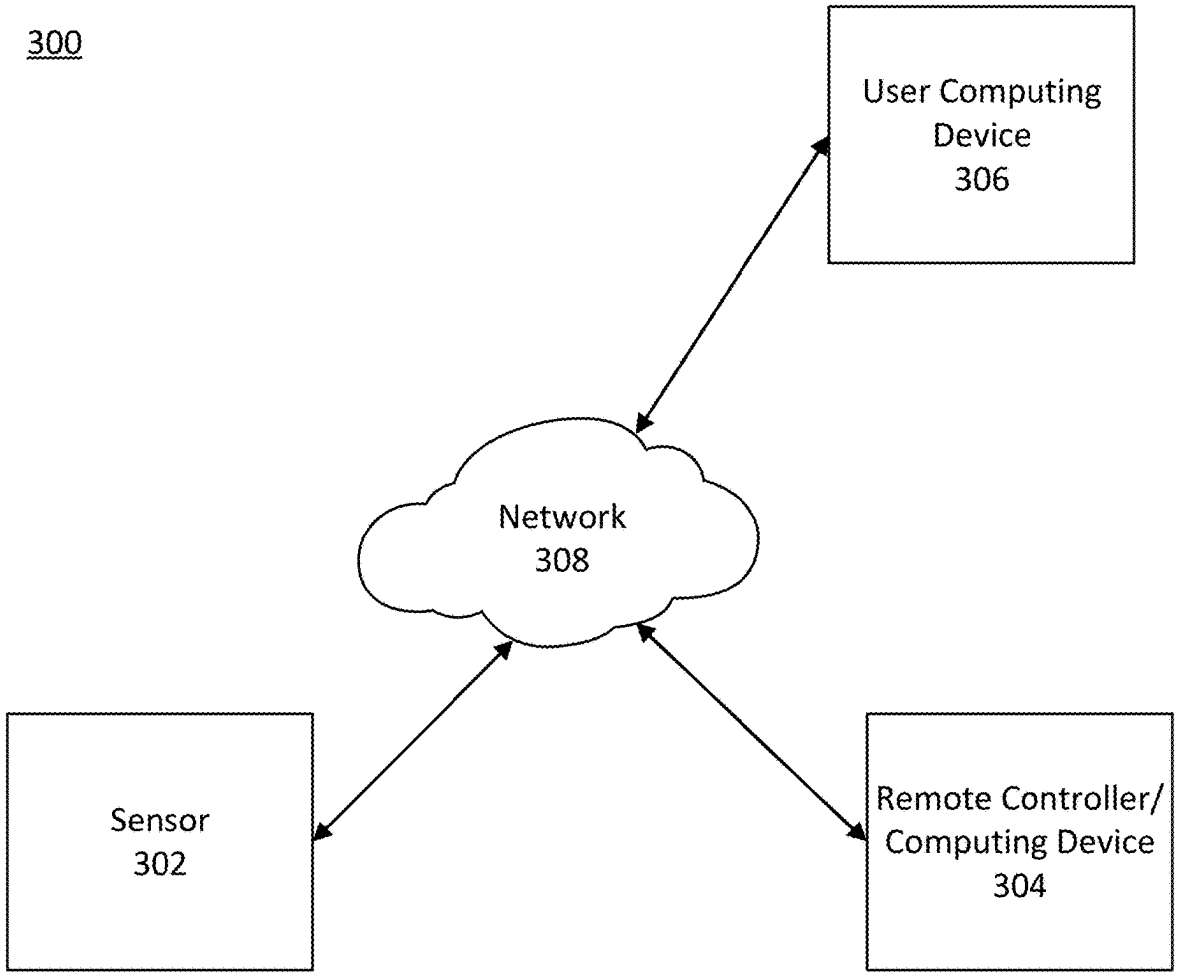

300
User Computing Device 306
Network 308
Sensor 302
Remote Controller/ Computing Device 304

FIG. 3

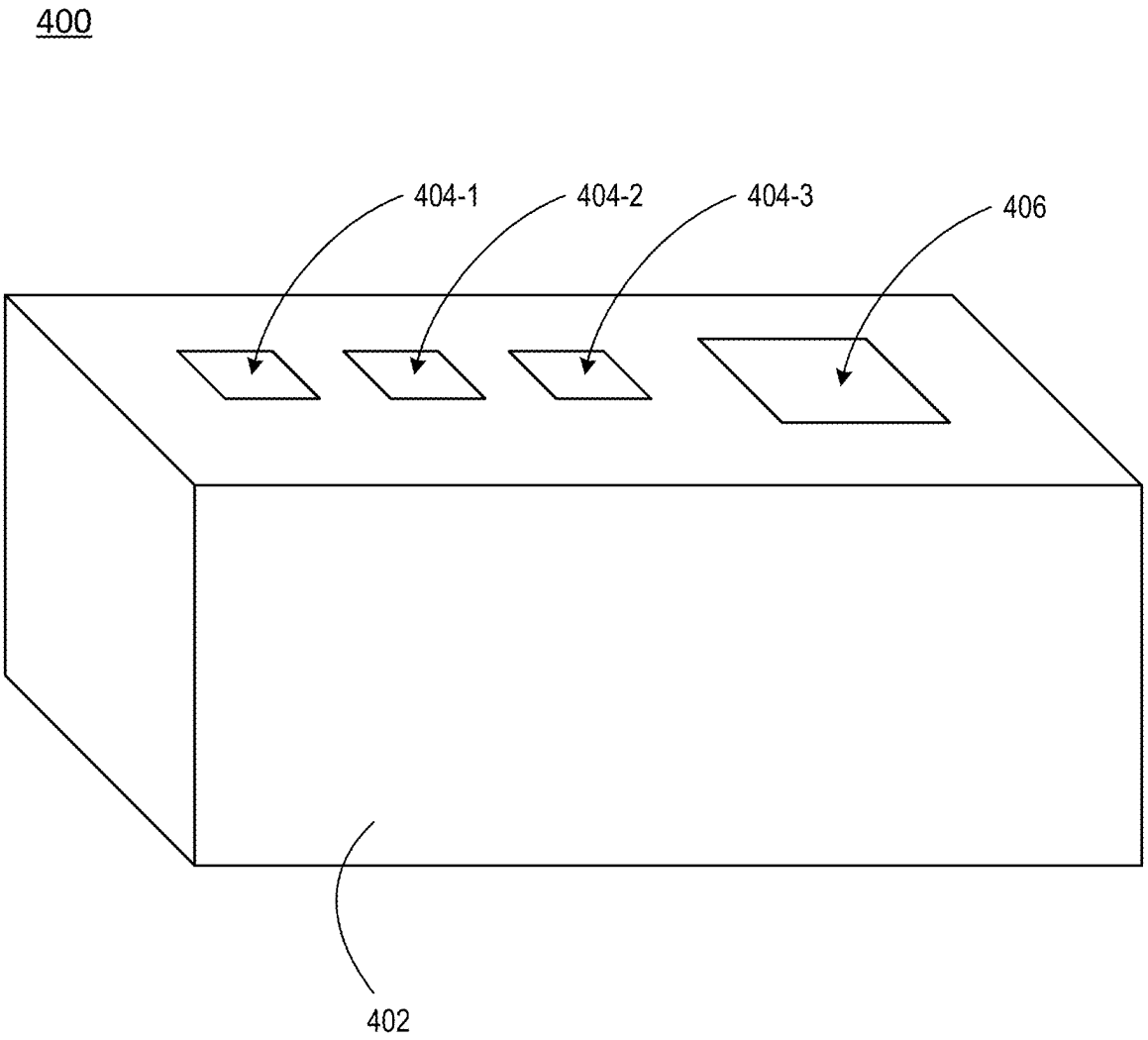


FIG. 4A

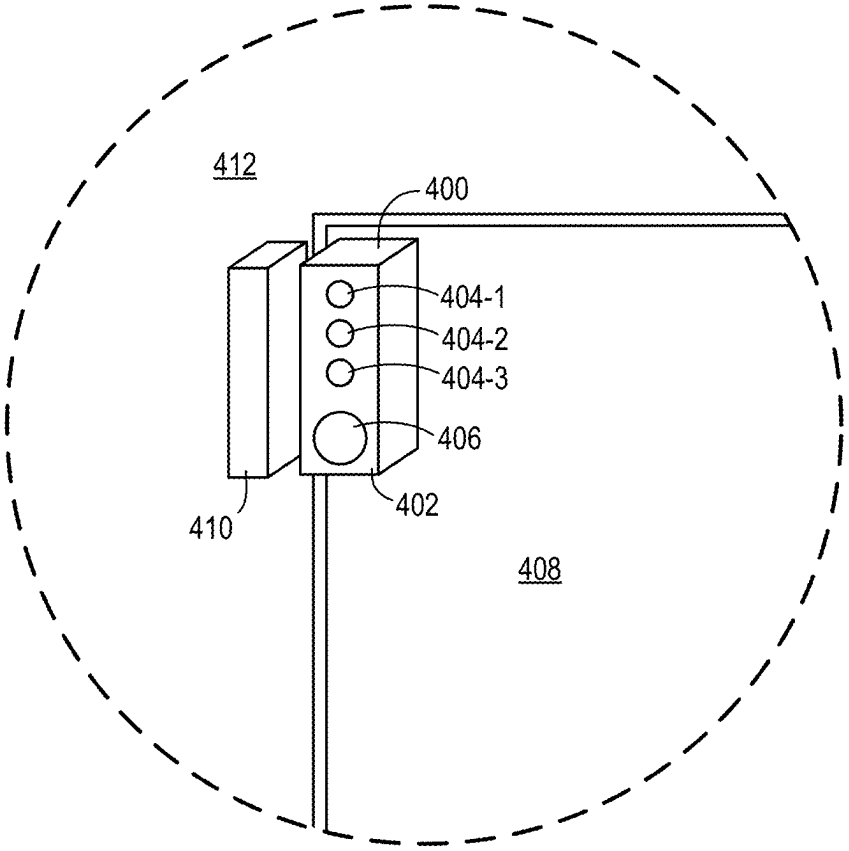


FIG. 4B

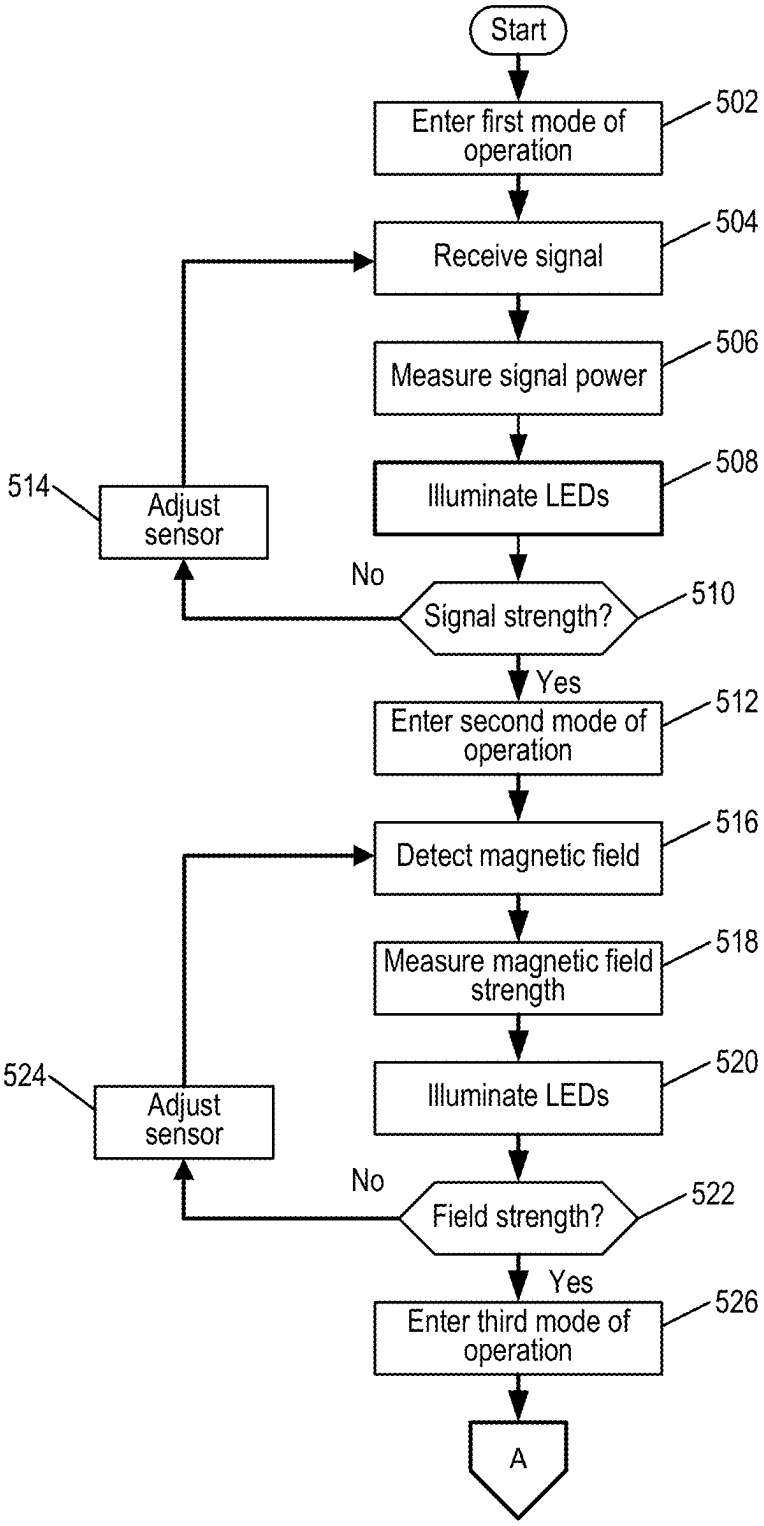

Start
Enter first mode of operation
502
Receive signal
504
Measure signal power
506
Illuminate LEDs
508
514
Adjust sensor
No
Signal strength?
510
Yes
Enter second mode of operation
512
Detect magnetic field
516
Measure magnetic field strength
518
524
Adjust sensor
Illuminate LEDs
520
No
Field strength?
522
Yes
Enter third mode of operation
526
A

FIG. 5A

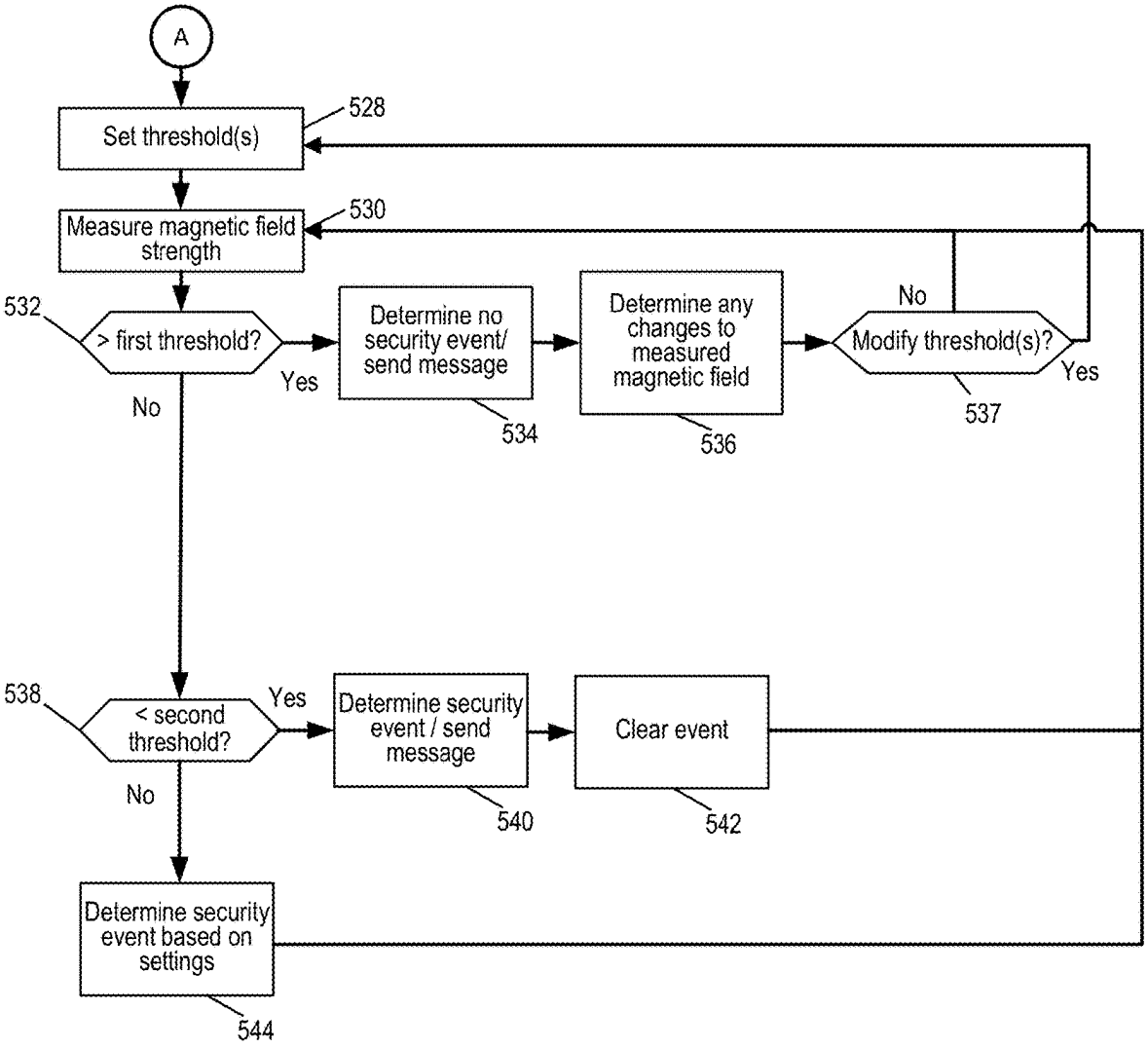

A
Set threshold(s)
528
Measure magnetic field strength
530
532
> first threshold?
Yes
No
Determine no security event/ send message
534
Determine any changes to measured magnetic field
536
Modify threshold(s)?
No
Yes
537
538
< second threshold?
Yes
No
Determine security event / send message
540
Clear event
542
Determine security event based on settings
544

FIG. 5B

600

Battery voltage field 602	Magnetic field strength field 604	Temp. field 606	RSSI field 608	LQI field 610	Retries field 612	Rejoins field 614

FIG. 6

700

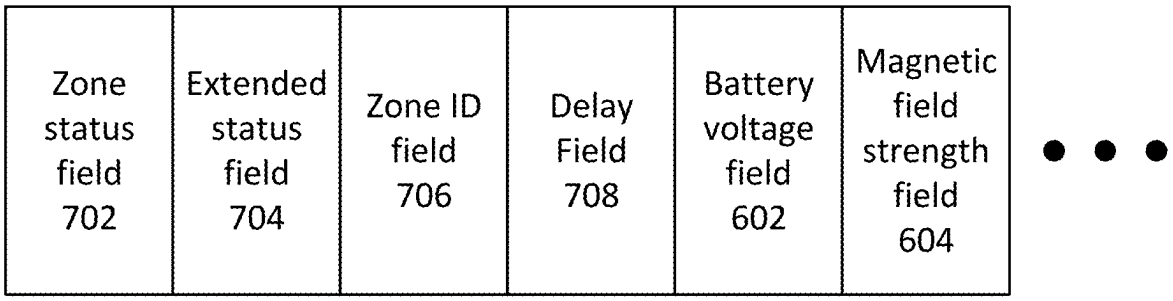

Zone status field 702
Extended status field 704
Zone ID field 706
Delay Field 708
Battery voltage field 602
Magnetic field strength field 604
Temp. field 606
RSSI field 608
LQI field 610
Retries field 612
Rejoins field 614

FIG. 7

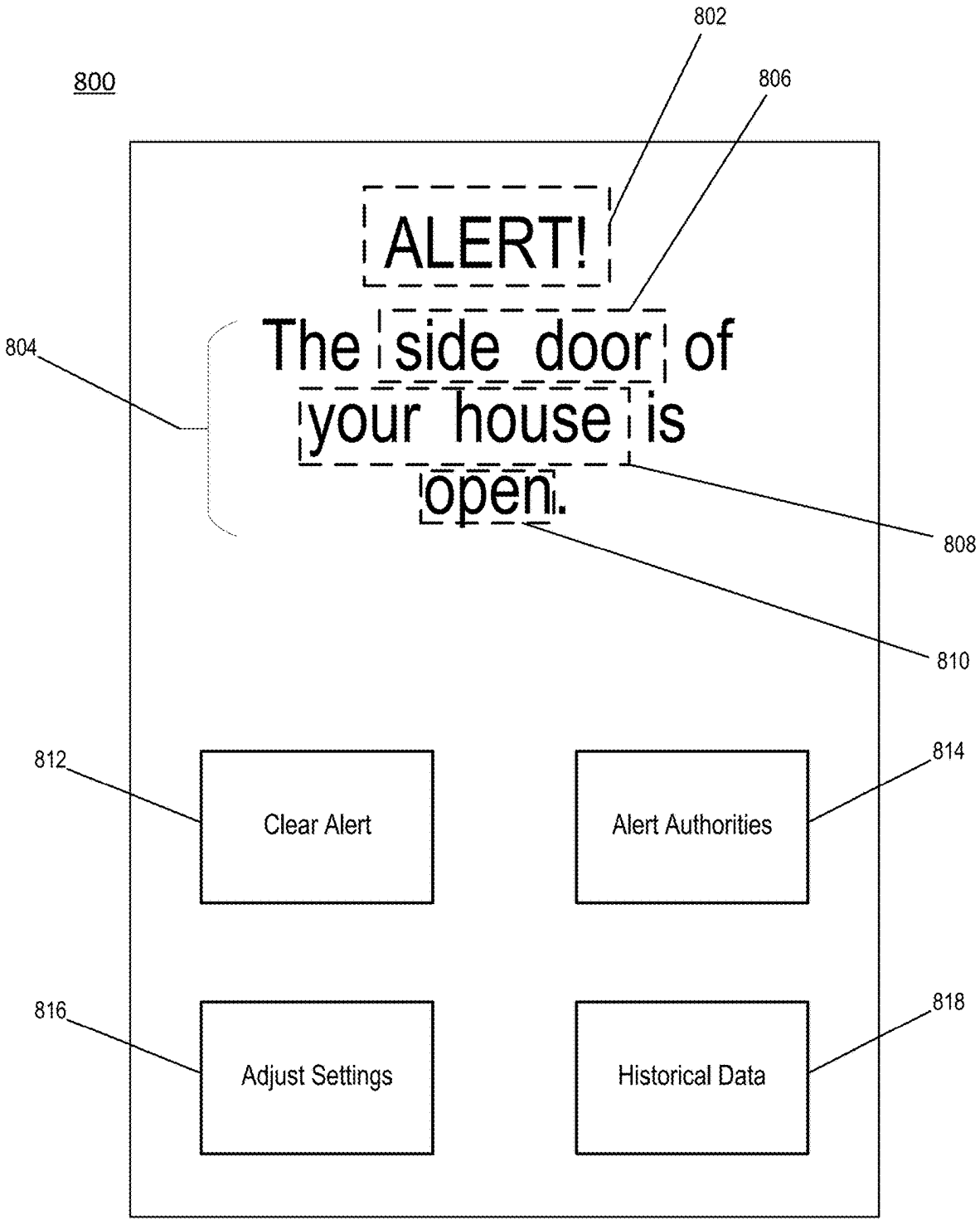

800
802
806
ALERT!
The side door of your house is open.
804
808
810
812
Clear Alert
814
Alert Authorities
816
Adjust Settings
818
Historical Data

FIG. 8

SYSTEMS AND METHODS FOR DETERMINING STATUS OF SENSORS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of and claims priority to U.S. patent application Ser. No. 17/898,285, filed Aug. 29, 2022, which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] A security system may rely on a sensor to report information. Over time, information reported by the sensor may become unreliable. Thus, there is a need to improve the reliability of information reported by a sensor over its lifetime.

SUMMARY

[0003] The following summary presents a simplified summary of certain features. The summary is not an extensive overview and is not intended to identify key or critical elements.

[0004] Systems, apparatuses, and methods are described for monitoring objects (e.g., a door or a window) to determine whether a security event is occurring with respect to the object (e.g., determining whether the door or window is open if the door or window should be closed). In one aspect, a sensor may be positioned on the object (e.g., the door) and an associated magnet may be placed in relatively close proximity to the sensor (e.g., the door frame). The sensor may be configured to detect a magnetic field of the magnet and to measure a strength of the magnetic field. The measured strength of the magnetic field may be compared to a threshold to determine if the door is open or closed. As the positioning of the sensor and/or the magnet changes over time, measurements made by the sensor of the strength of the magnetic field may also change. The threshold for determining whether the door is open or closed may be adjusted (e.g., increased or decreased) to account for changes in the measurements of the strength of the magnetic field made by the sensor. In doing so, false determinations that the door is open when in fact the door is closed may be avoided and/or false determinations that the door is closed when in fact the door is open may be avoided.

[0005] These and other features and advantages are described in greater detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Some features are shown by way of example, and not by limitation, in the accompanying drawings. In the drawings, like numerals reference similar elements.

[0007] FIG. **1** shows an example communication network.

[0008] FIG. **2** shows example components of a computing device.

[0009] FIG. **3** shows an example security monitoring system.

[0010] FIG. **4**A shows an example sensor.

[0011] FIG. **4**B shows an example installation of the sensor of FIG. **4**A.

[0012] FIGS. **5**A and **5**B are a flow chart showing steps of an example method associated with security monitoring.

[0013] FIG. **6** shows a first example message.

[0014] FIG. **7** shows a second example message.

[0015] FIG. **8** shows an example user interface.

DETAILED DESCRIPTION

[0016] The accompanying drawings, which form a part hereof, show examples of the disclosure. It is to be understood that the examples shown in the drawings and/or discussed herein are non-exclusive and that there are other examples of how the disclosure may be practiced.

[0017] A security monitoring system may comprise a sensor and a remote controller. The remote controller may be located remote or apart from the sensor or the sensor may be an integrated part of the remote controller. The sensor may be positioned on a door (or a window) and an associated magnet may be positioned on a corresponding door frame (or a corresponding window frame). Alternatively, the sensor may be positioned on the door or window frame, and the magnet may be positioned on the door or window. The sensor may be a Hall effect sensor configured to measure a strength of a magnetic field from the magnet. The measured strength of the magnetic field may be reported to the remote controller. The sensor and/or the remote controller may compare the measured strength of the magnetic field to one or more thresholds to determine if the door (or window) is open or closed. The sensor and/or the remote controller may track measurements of the magnetic field strength made over time when the door (or window) is closed. The sensor and/or the remote controller may adjust the one or more thresholds based on trends in the measurements of the magnetic field strength. For example, a threshold may be lowered based on a changed position of the sensor or the magnet, which may result in a lower measured magnetic field strength if the door is closed. By adjusting the threshold to account for changes in the positioning and/or alignment of the sensor or magnet over time due to normal wear and tear on the door (or window), the security monitoring system may avoid falsely indicating that the door (or window) is open if the door is actually closed. Similarly, a threshold may be increased based on a changed position of the sensor or the magnet, which may result in an increased measured magnetic field strength if the door is closed. By adjusting the threshold to account for changes in the positioning and/or alignment of the sensor or magnet over time due to normal wear and tear on the door (or window), the security monitoring system may also avoid falsely indicating that the door (or window) is closed if the door is actually open.

[0018] FIG. **1** shows an example communication network **100** in which features described herein may be implemented. The communication network **100** may comprise one or more information distribution networks of any type, such as, without limitation, a telephone network, a wireless network (e.g., an LTE network, a 5G network, a Wi-Fi IEEE 802.11 network, a WiMAX network, a satellite network, and/or any other network for wireless communication), an optical fiber network, a coaxial cable network, and/or a hybrid fiber/coax distribution network. The communication network **100** may use a series of interconnected communication links **101** (e.g., coaxial cables, optical fibers, wireless links, etc.) to connect multiple premises **102** (e.g., businesses, homes, consumer dwellings, train stations, airports, etc.) to a local office **103** (e.g., a headend). The local office **103** may send downstream information signals and receive upstream information signals via the communication links **101**. Each of the premises **102** may comprise devices, described below, to

receive, send, and/or otherwise process those signals and information contained therein.

[0019] The communication links **101** may originate from the local office **103** and may comprise components not shown, such as splitters, filters, amplifiers, etc., to help convey signals clearly. The communication links **101** may be coupled to one or more wireless access points **127** configured to communicate with one or more mobile devices **125** via one or more wireless networks. The mobile devices **125** may comprise smart phones, tablets or laptop computers with wireless transceivers, tablets or laptop computers in communication with other devices with wireless transceivers, and/or any other type of device configured to communicate via a wireless network.

[0020] The local office **103** may comprise an interface **104**. The interface **104** may comprise one or more computing devices configured to send information downstream to, and to receive information upstream from, devices communicating with the local office **103** via the communications links **101**. The interface **104** may be configured to manage communications among those devices, to manage communications between those devices and backend devices such as servers **105-107**, and/or to manage communications between those devices and one or more external networks **109**. The interface **104** may, for example, comprise one or more routers, one or more base stations, one or more optical line terminals (OLTs), one or more termination systems (e.g., a modular cable modem termination system (M-CMTS) or an integrated cable modem termination system (I-CMTS)), one or more digital subscriber line access modules (DSLAMs), and/or any other computing device(s). The local office **103** may comprise one or more network interfaces **108** that comprise circuitry needed to communicate via the external networks **109**. The external networks **109** may comprise networks of Internet devices, telephone networks, wireless networks, wired networks, fiber optic networks, and/or any other desired network. The local office **103** may also or alternatively communicate with the mobile devices **125** via the interface **108** and one or more of the external networks **109**, e.g., via one or more of the wireless access points **127**.

[0021] The push notification server **105** may be configured to generate push notifications to deliver information to devices in the premises **102** and/or to the mobile devices **125**. The content server **106** may be configured to provide content to devices in the premises **102** and/or to the mobile devices **125**. This content may comprise, for example, video, audio, text, web pages, images, files, etc. The content server **106** (and/or an authentication server) may comprise software to validate user identities and entitlements, to locate and retrieve requested content, and/or to initiate delivery (e.g., streaming) of the content. The application server **107** may be configured to offer any desired service. For example, an application server may be responsible for collecting, and generating a download of, information for electronic program guide listings. Another application server may be responsible for monitoring user viewing habits and collecting information from that monitoring for use in selecting advertisements. Yet another application server may be responsible for formatting and inserting advertisements in a video stream being transmitted to devices in the premises **102** and/or to the mobile devices **125**. The local office **103** may comprise additional servers, such as additional push, content, and/or application servers, and/or other types of servers. Also or alternatively, one or more servers may be part of the external network **109** and may be configured to communicate (e.g., via the local office **103**) with computing devices located in or otherwise associated with one or more premises **102** and/or with mobile devices **125**.

[0022] An example premises **102***a* may comprise an interface **120**. The interface **120** may comprise circuitry used to communicate via the communication links **101**. The interface **120** may comprise a modem **110**, which may comprise transmitters and receivers used to communicate via the communication links **101** with the local office **103**. The modem **110** may comprise, for example, a coaxial cable modem (for coaxial cable lines of the communication links **101**), a fiber interface node (for fiber optic lines of the communication links **101**), twisted-pair telephone modem, a wireless transceiver, and/or any other desired modem device. One modem is shown in FIG. **1**, but a plurality of modems operating in parallel may be implemented within the interface **120**. The interface **120** may comprise a gateway **111**. The modem **110** may be connected to, or be a part of, the gateway **111**. The gateway **111** may be a computing device that communicates with the modem(s) **110** to allow one or more other devices in the premises **102***a* to communicate with the local office **103** and/or with other devices beyond the local office **103** (e.g., via the local office **103** and the external network(s) **109**). The gateway **111** may comprise (and/or otherwise perform operations of) a set-top box (STB), digital video recorder (DVR), a digital transport adapter (DTA), a computer server, a router, and/or any other desired computing device.

[0023] The gateway **111** may also comprise one or more local network interfaces to communicate, via one or more local networks, with devices in the premises **102***a*. Such devices may comprise, e.g., display devices **112** (e.g., televisions), other devices **113** (e.g., a DVR or STB), personal computers **114**, laptop computers **115**, wireless devices **116** (e.g., wireless routers, wireless laptops, notebooks, tablets and netbooks, cordless phones (e.g., Digital Enhanced Cordless Telephone—DECT phones), mobile phones, mobile televisions, personal digital assistants (PDA)), landline phones **117** (e.g. Voice over Internet Protocol—VoIP phones), and any other desired devices. Example types of local networks comprise Multimedia Over Coax Alliance (MoCA) networks, Ethernet networks, networks communicating via Universal Serial Bus (USB) interfaces, wireless networks (e.g., IEEE 802.11, IEEE 802.15, Bluetooth), networks communicating via in-premises power lines, and others. The lines connecting the interface **120** with the other devices in the premises **102***a* may represent wired or wireless connections, as may be appropriate for the type of local network used. One or more of the devices at the premises **102***a* may be configured to provide wireless communications channels (e.g., IEEE 802.11 channels) to communicate with one or more of the mobile devices **125**, which may be on- or off-premises.

[0024] The mobile devices **125**, one or more of the devices in the premises **102***a*, and/or other devices may receive, store, output, process, and/or otherwise use data associated with content items. A content item may comprise a video, a game, one or more images, software, audio, text, webpage (s), and/or other type of content. One or more types of data may be associated with a content item. A content item may, for example, be associated with media data (e.g., data encoding video, audio, and/or images) that may be pro-

cessed to cause output of the content item via a display screen, a speaker, and/or other output device component.

[0025] The other devices **113** may comprise a sensor (e.g., a Hall effect sensor) that may be configured to detect if a door or a widow (or other object) is opened or closed. The other devices **113** may also comprise a remote controller that may be configured to communicate with the sensor over a network such as, for example, a network within the premises **102***a* (e.g., via wireless device **116**). The sensor may communicate information related to security events detected by the sensor to the remote controller. Security events may comprise detecting if a door or a window is opened and/or if a door or a window is closed. The remote controller may be configured to monitor operation of the sensor and/or to adjust or modify operation of the sensor. The remote controller and the sensor may be separate devices or may be integrated to form one physical device (e.g., the sensor may be a part of the controller).

[0026] The remote controller may be further configured to communicate information related to security events to one or more of the mobile devices **125** via, for example, the wireless access points **127** and/or the wireless device **116** (e.g., a wireless router). A user of the mobile device **125** may be able to monitor a security of the premises **125** based on operation of the sensor and the remote controller. As described above, one or more servers may be communicatively coupled to the external network **109**. For example, a security monitoring server **140** may communicate with the local office **103** (and/or one or more other local offices), one or more premises **102**, one or more access points **127**, one or more mobile devices **125**, and/or one or more other computing devices via the external network **109**. The security monitor server **140** may monitor and control operations of the sensor and/or the remote controller based on user preferences and settings. The security monitor server **140** may also enable the mobile devices **125** to receive alerts related to security events detected by the sensor and/or the remote controller if the mobile devices **125** are located remote from the premises **125***a*.

[0027] Also or alternatively, the security monitor server **140** may be located in the local office **103**, in a premises **102**, and/or elsewhere in a network. The security monitor server **140** may communicate with a security monitor database **141**. The security monitor database **141** may store data that may be used in connection with security event monitoring operations performed by the security monitor server **140**, the sensor, and/or the remote controller. For example, data may be maintained for use in establishing default security monitoring operations and alert settings of security monitor server **140**, the sensor, and/or the remote controller, as desired by a user of the mobile device **125**. Although shown as a separate element, the security monitor database **141** may be part of the security monitor server **140**. Also or alternatively, the push server **105**, the content server **106**, the application server **107**, the security monitor server **140**, and/or other server(s) may be combined. The servers **105**, **106**, **107**, and **140**, other servers, and/or the security monitor database **141** may be computing devices and may comprise memory storing data and also storing computer executable instructions that, when executed by one or more processors, cause the server(s) to perform steps described herein.

[0028] Any component depicted and described in relation to FIG. **1**—including, for example, the sensor, the remote controller, the mobile devices **125**, the security monitor server **140**, and/or the security monitor database **141**—may form a security monitoring system (e.g., a security system) or a portion thereof, as further described herein. The security monitoring system may detect and report security events to a user based on preferences specified by the user.

[0029] FIG. **2** shows hardware elements of a computing device **200** that may be used to implement any of the computing devices shown or described in relation to FIG. **1** (e.g., the mobile devices **125**, any of the devices shown in the premises **102***a*, any of the devices shown in the local office **103**, any of the wireless access points **127**, the security monitor server **140**, the security monitor **141**, any devices that are part of or associated with the external network **109**) and any other computing devices discussed herein (e.g., a remote control unit associated with the gateway **111** and/or with another computing device). The computing device **200** may be used to implement the sensor and or the remote controller described in relation to FIG. **1** (e.g., as one or more other devices **113**). The computing device **200** may comprise one or more processors **201**, which may execute instructions of a computer program to perform any of the functions described herein. The instructions may be stored in a non-rewritable memory **202** such as a read-only memory (ROM), a rewritable memory **203** such as random access memory (RAM) and/or flash memory, removable media **204** (e.g., a USB drive, a compact disk (CD), a digital versatile disk (DVD)), and/or in any other type of computer-readable storage medium or memory. Instructions may also be stored in an attached (or internal) hard drive **205** or other types of storage media. The computing device **200** may comprise one or more output components, such as a display device **206** (e.g., an external television and/or other external or internal display device) and a speaker **214**, and may comprise one or more output device controllers **207**, such as a video processor or a controller for an infra-red or BLUETOOTH transceiver. One or more user input devices **208** may comprise a remote control, a keyboard, a mouse, a touch screen (which may be integrated with the display device **206**), a microphone, etc. The computing device **200** may, for example receive sounds of speech input via a microphone. The processor **201** may (e.g., using one or more analog-to-digital (A/D) converters, digital signal processors (DSPs), and/or other components) digitize and/or otherwise generate audio data that is representative of the speech input. Also or alternatively, the computing device may comprise (e.g., in addition to the processor **201**) one or more A/D converters, DSPs, and/or other components that generate audio data that is representative of the speech input. The processor **201** and/or other components of the computing device may send speech data to one or more other computing devices, may receive (e.g., via network input/output (I/O) interface **210**, described below) speech data generated by another computing device, may perform speech recognition processing of speech data, and/or may perform other operations associated with speech data.

[0030] The computing device **200** may also comprise one or more network interfaces, such as the network I/O interface **210** (e.g., a network card), to communicate with an external network **209**. The network I/O interface **210** may be a wired interface (e.g., electrical, RF (via coax), optical (via fiber)), a wireless interface, or a combination of the two. The network I/O interface **210** may comprise a modem configured to communicate via the external network **209**. The external network **209** may comprise the communication

links **101** discussed above, the external network **109**, an in-home network, a network provider's wireless, coaxial, fiber, or hybrid fiber/coaxial distribution system (e.g., a DOCSIS network), or any other desired network. The computing device **200** may comprise a location-detecting device, such as a global positioning system (GPS) microprocessor **211**, which may be configured to receive and process global positioning signals and determine, with possible assistance from an external server and antenna, a geographic position of the computing device **200**.

[0031] Although FIG. **2** shows an example hardware configuration, one or more of the elements of the computing device **200** may be implemented as software or a combination of hardware and software. Modifications may be made to add, remove, combine, divide, etc. components of the computing device **200**. Additionally, the elements shown in FIG. **2** may be implemented using basic computing devices and components that have been configured to perform operations such as are described herein. For example, a memory of the computing device **200** may store computer-executable instructions that, when executed by the processor **201** and/or one or more other processors of the computing device **200**, cause the computing device **200** to perform one, some, or all of the operations described herein. Such memory and processor(s) may also be implemented through one or more Integrated Circuits (ICs). An IC may be, for example, a microprocessor that accesses programming instructions or other data stored in a ROM and/or hardwired into the IC. For example, an IC may comprise an Application Specific Integrated Circuit (A SIC) having gates and/or other logic dedicated to the calculations and other operations described herein. An IC may perform some operations based on execution of programming instructions read from ROM or RAM, with other operations hardwired into gates or other logic. Further, an IC may be configured to output image data to a display buffer.

[0032] FIG. **3** shows a system **300** for monitoring security events. The system **300** may comprise a security system or a portion thereof. The system **300** may comprise a sensor **302**, a remote controller **304**, a user device **306**, and a network **308**. The system **300** may comprise one or more components depicted and described in relation to FIG. **1**. For example, the sensor **302** may comprise one of the other devices **113**, the remote controller **304** may comprises one of the other devices **113**, the user device **306** may comprise one of the mobile devices **125** or one of the wireless devices **116**, and the network **308** may comprise a network provided by one of the wireless devices **116** and/or one of the wireless access points **127** and may include the external network **109**. The system **300** may be a portion of the communications network **100** depicted in FIG. **1**.

[0033] The sensor **302** may comprise any type of sensor including, for example, a Hall effect sensor (or Hall sensor). The sensor **302** may be positioned anywhere within a premises (e.g., the premises **102***a*). The sensor **302** may be positioned so as to detect a movement of any item or object within the premises and/or to detect a change in a position of any item or object within the premises. As a first example, the sensor **302** may be positioned on a door to detect if the door is open or if the door is closed. As a second example, the sensor **302** may be positioned on a window to detect if the window is open or if the window is closed.

[0034] The sensor **302** may be configured to detect a magnetic field and to output an indication of a strength of the magnetic field (e.g., output an indication of a measured magnetic flux density). For example, the sensor **302** may output a signal (e.g., a voltage signal) indicating a strength of the magnetic field. The output signal may vary according to a strength of the magnetic field. For example, the sensor **302** may be positioned on a door and an associated magnet may be positioned on a door frame. If the door is closed, the sensor **302** may be in relatively close proximity to the magnet. As a result, the sensor **302** may detect a relatively strong magnetic field and may output a first signal indicating detection of the relatively strong magnetic field. The first output signal may be interpreted as indicating that the door is closed. If the door is open, the sensor **302** may no longer be in relatively close proximity to the magnet. As a result, the sensor **302** may detect a relatively weak magnetic field and may output a second signal indicating detection of the relatively weak magnetic field. The second output signal may be interpreted as indicating that the door is open.

[0035] The sensor **302** may comprise a computing device such as, for example, the computing device **200**. The sensor **302** may comprise one or more processors and a memory. The sensor **302** may comprise a battery to power the sensor **302**. As described above, the sensor **302** may be associated with a magnet. The sensor **302** may be positioned on a moveable item (e.g., the moveable portion of a door or a window) while the magnet may be positioned on an associated immovable item (e.g., a door frame or a window frame) that is in relatively close proximity to the sensor **302**.

[0036] The remote controller **304** may be positioned anywhere within the premises (e.g., the premises **102***a*). The remote controller **304** may be positioned remote from the sensor **302** and may be configured to communicate with the sensor **302** over the network **306**. The remote controller **304** and the sensor **302** may communicate wirelessly or over a wired link provided by the network **308**. The remote controller **304** and the sensor **302** may be separate devices or may be integrated to form one physical device (e.g., the sensor **302** may be a part of the remote controller **304**). If the remote controller **304** and the sensor **302** are integrated to form one physical device, then the functionality of the remote controller **304** as described herein may comprised in the sensor **302** (e.g., the sensor **302** may provide the functionality of the remote controller **304**).

[0037] The sensor **302** may be configured to provide output signals (e.g., indications of a strength of a magnetic field as a measured by the sensor **302**) to the remote controller **304**. The sensor **302** may provide the output signals periodically and/or may provide an output signal responsive to a detected change in a strength of a magnetic field. For example, the sensor **302** may be positioned on a door and may monitor a strength of a magnetic field from an associated magnet positioned on a door frame. The sensor **302** may measure the strength of the magnetic field. Output signals indicating the strength of the measured magnetic field may be periodically reported to the remote controller **304** and/or may be provided to the remote controller **304** based on a detected change to a strength of the magnetic field (e.g., if the door is closed after being open or if the door is open after being closed).

[0038] The remote controller **304** receives the output signals from the sensor **302**. The remote controller **304** may compare a received output signal to one or more thresholds to determine whether the door is open or closed. For example, the remote controller **304** may compare a received

output signal to a first threshold. If the output signal indicates that a detected magnetic field strength satisfies the first threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the first threshold), the remote controller **304** may determine the door is closed. If the output signal indicates that a detected magnetic field strength does not satisfy the first threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the first threshold), the remote controller **304** may determine the door is open. The status of the door as open or closed may be a security event. In this manner, the sensor **302** and the remote controller **304** may operate to monitor security events to determine a state of any object or item (e.g., to determine if a door, window, or other item is in a closed state, an open state, and/or an intermediate partially open state).

[0039] A Iso or alternatively, the remote controller **304** may compare a received output signal to a first threshold and to a second threshold. The first threshold may have a value or magnitude that is greater than the second threshold. If the output signal indicates that a detected magnetic field strength satisfies the first threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the first threshold), the remote controller **304** may determine the door is closed. If the output signal indicates that a detected magnetic field strength does not satisfy the second threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the second threshold, the remote controller **304** may determine the door is open. If the output signal indicates a detected magnetic field strength does not satisfy the first threshold (is less than, or less than or equal to, a magnetic field strength associated with the first threshold) and satisfies the second threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the second threshold), the remote controller **304** may interpret such an output signal as indicating that the door is in the process of being opened or in the process of being closed and/or is in a partially opened/closed intermediate state (e.g., based on a prior state of the door as determined based on comparison of a prior output signal to the first threshold and the second threshold). The remote controller **304** may determine the door is opened (e.g., partially opened) if the one or more subsequent output signals from the sensor **302** are between the first threshold and the second threshold.

[0040] The remote controller **304** may comprise a computing device such as, for example, the computing device **200**. The remote controller **304** may be communicatively coupled (e.g., over the network **308**) to any number of any type of sensors positioned throughout a premises including, for example, one or more Internet of Things (IoT) devices.

[0041] The user device **306** may be any type of user device including, for example, a mobile device, a smartphone, a tablet, a laptop computer, a desktop computer, or an equivalent thereof. The user device **304** may comprise a computing device such as, for example, the computing device **200**. The user device **306** may be communicatively coupled (e.g., over the network **308**) to the sensor **302** and/or the remote controller **304**. The remote controller **304** may provide information to the user device **306** based on operation of the sensor **302**. For example, the remote controller **304** may provide information to the user device **306** indicating the status of a door to which the sensor **302** is coupled or attached—for example, whether the door is open or is closed. In this manner, security events associated with an object to which the sensor **302** is attached may be reported to a user or operator of the system **300**, thereby allowing the user to monitor the security of a premises.

[0042] The user device **306** may comprise a user interface (e.g., via an application or app) to control or manage operation of the sensor **302** and/or the remote controller **304**. The user interface may provide a visual and/or audible indication of a status of the operation of the sensor **302** and/or the status of an object (e.g., a door) to which the sensor **302** is attached. For example, if a door to which the sensor **302** is attached is opened, the user interface may provide an indication that the door is open-based on operation of the sensor **302** and/or the remote controller **304**. The user interface provided by the user device **306** may indicate a variety of information related to a security event such as for example, if a door was opened, how long the door remained open, and/or if the door was closed.

[0043] A user of the user device **306** may specify preferences for monitoring security events using the user interface. For example, the user interface may allow a user to receive an alert anytime the door is opened. Alternatively or additionally, the user interface may allow the user to receive an alert only if the door has been opened for an amount of time that exceeds a threshold amount of time. The threshold amount of time may be set to any value or amount of time. The threshold amount of time may be set or adjusted by the user via the user interface of the user device **308**.

[0044] The network **308** may be any type of communications and/or computer network. The network **308** may comprise any type of communication mediums and/or may be based on any type of communication standards or protocols. The network **308** may communicatively couple the sensor **302**, the remote controller **304**, and the user device **306**, to enable data or other information to be shared across any of the devices depicted in FIG. **3**. The network **308** may operate according to any number of communication specifications or protocols such as, for example, Zigbee, WiFi, or Ethernet.

[0045] The remote controller **304** and/or the sensor **302** may store one or more thresholds for determining whether a door is open or closed. The thresholds may be adjusted by the remote controller **304**, the sensor **302**, and/or the user device **306**. The thresholds may be adjusted automatically by the remote controller **304**, the sensor **302**, and/or the user device **306** or the thresholds may be adjusted responsive to a user input, command, or instruction (e.g., issued via the user interface of the user device **306**). The thresholds may also be stored and/or adjusted by the security monitor server **140** and/or the security monitor database **141**.

[0046] A first threshold for determining whether the door is open or closed may be set to any value. The first threshold for determining whether the door is open or closed may be set based on test measurements during installation of the sensor **302**. For example, during installation of the sensor **302**, the sensor **302** may be securely attached to a door and if the door is closed the sensor **302** may detect and measure a first relatively strong magnetic field. The first threshold may be set based on the first relatively strong magnetic field measured by the sensor **302** at the time of installation. As a first example, the first threshold may be set to be a predetermined percentage of (or a predetermined percentage lower than) the first relatively strong magnetic field measured by the sensor **302** (e.g., the first threshold may be set

to have a value that is 75% of the value of the first relatively strong magnetic field measured by the sensor **302**). As a second example, the first threshold may be set to be a predetermined amount less than the first relatively strong magnetic field measured by the sensor **302** (e.g., the first threshold may be set to have a value that is 10 mT less than the value of the first relatively strong magnetic field measured by the sensor **302**). The predetermined percentage and/or the predetermined amount less may be stored by or hard coded into any of the devices that may set or adjust the first threshold. The predetermined percentage and/or the predetermined amount less may be set or adjusted responsive to a user input, command, or instruction (e.g., issued via the user interface of the user device **306**).

[0047] The first threshold may also be set based on a set of first relatively strong magnetic field measurements made by the sensor **302** at the time of installation. For example, two or more measurements of a relatively strong magnetic field made by the sensor **302** may be averaged to determine an average measured strength value that is then used to set the first threshold. The first threshold may be set to be a predetermined percentage of (or a predetermined percentage lower than) than the average measured strength value. The first threshold may be set to be a predetermined amount less than the average measured strength value. Alternatively, the first threshold may be set to be a predetermined percentage of (or a predetermined percentage lower than) than the lowest measured strength value of the set of first relatively strong magnetic field measurements made by the sensor **302**. The first threshold may be set to be a predetermined amount less than the lowest measured strength value of the set of first relatively strong magnetic field measurements made by the sensor **302**.

[0048] Over time, as the door is used, the attachment of the sensor **302** to the door (or the magnet to the door frame) may change. For example, an alignment or position of the sensor **302** (e.g., relative to an associated magnet) may change over time, such that if the door is closed the sensor may detect a slightly weaker magnetic field (e.g., a second relatively strong magnetic field). The second relatively strong magnetic field detected by the sensor **302** may satisfy the first threshold (e.g., be greater than the first threshold), but may be less than the first relatively strong magnetic field. The remote controller **304** may monitor changes in magnetic field strengths measured by the sensor **302** when the door is closed. Based on the changes to the magnetic field measurements over time, the remote controller **304** may adjust the first threshold. For example, the remote controller **304** may determine to lower the first threshold to reduce a likelihood that a measured magnetic field strength when the door is closed is erroneously interpreted as indicating that the door is open. The remote controller **304** may report a change to the first threshold to the user device **306**. Changes to any threshold may be made in this manner may be implemented automatically or may require user confirmation via the user device **306**. Alternatively or additionally, the changes over time to the strength of the magnetic field measured by the sensor **302** when the door is closed may be reported to the user device **308**, and the user device **308** may be configured to allow a user to adjust the first threshold.

[0049] The remote controller **304** may determine a reduction in a strength of the magnetic field and/or may determine a downward trend in a strength of the magnetic field (e.g., over a period of time) based on measurements made by the sensor **302** and reported to the remote controller **304**. The remote controller **304** may determine reductions or trends in the strength of the magnetic field based on determining that one or more measured strengths of the magnetic field are within a first predetermined range (or amount) of the first threshold. For example, a set of measurements made by the sensor **302** may each be within the first predetermined range of the first threshold. Alternatively and/or additionally, the remote controller **304** may determine reductions or trends in the strength of the magnetic field based on determining that one or more measured strengths of the magnetic field are less than one or more initial relatively strong magnetic field measurements made by the sensor **302** by at least a second predetermined amount. For example, the remote controller **304** may determine the reduction in the strength of the magnetic field based on a lowest measured strength of the magnetic field being less than a first relatively strong magnetic field measurements made by the sensor **302**, by the second predetermined amount. The first predetermined range and the second predetermined amount may be set to any value and may be configurable by any device described herein or may be set or adjust by a user.

[0050] Similarly, an alignment or position of the sensor **302** (e.g., relative to an associated magnet) may change over time, such that if the door is closed the sensor may detect a slightly stronger magnetic field (e.g., a second relatively strong magnetic field). The second relatively strong magnetic field detected by the sensor **302** may satisfy the first threshold (e.g., be greater than the first threshold), and may be greater than the first relatively strong magnetic field. The remote controller **304** may monitor changes in magnetic field strengths measured by the sensor **302** when the door is closed. Based on the changes to the magnetic field measurements over time, the remote controller **304** may adjust the first threshold. For example, the remote controller **304** may determine to increase the first threshold to reduce a likelihood that a measured magnetic field strength when the door is open is erroneously interpreted as indicating that the door is closed. The remote controller **304** may report a change to the first threshold to the user device **306**. Changes to any threshold may be made in this manner may be implemented automatically or may require user confirmation via the user device **306**. Alternatively or additionally, the changes over time to the strength of the magnetic field measured by the sensor **302** when the door is closed may be reported to the user device **308**, and the user device **308** may be configured to allow a user to adjust the first threshold.

[0051] The remote controller **304** may determine an increase in a strength of the magnetic field and/or may determine an upward trend in a strength of the magnetic field (e.g., over a period of time) based on measurements made by the sensor **302** and reported to the remote controller **304**. The remote controller **304** may determine increases or trends in the strength of the magnetic field based on determining that one or more measured strengths of the magnetic field are within a first predetermined range (or amount) of the first threshold. For example, a set of measurements made by the sensor **302** may each be within the first predetermined range of the first threshold. Alternatively and/or additionally, the remote controller **304** may determine increases or trends in the strength of the magnetic field based on determining that one or more measured strengths of the magnetic field are greater than one or more initial relatively strong magnetic field measurements made by the sensor **302** by at least a

second predetermined amount. For example, the remote controller **304** may determine the increase in the strength of the magnetic field based on a lowest measured strength of the magnetic field being greater than a first relatively strong magnetic field measurements made by the sensor **302**, by the second predetermined amount. The first predetermined range and the second predetermined amount may be set to any value and may be configurable by any device described herein or may be set or adjust by a user.

[0052] FIG. **4**A shows an example sensor **400**. The sensor **400** may be an implementation of the sensor **302**. The sensor may be a Hall effect sensor, or other magnetic field detection sensor or position detection sensor. The sensor **400** may be configured to be attached or coupled to an object and may be configured to detect a movement or a closed or open state of the object.

[0053] As shown in FIG. **4**A, the sensor **400** may comprise a cover or body **402**, light emitting diodes (LEDs) **404**, and a button **406**. The sensor **400** is shown with three LEDs **404**: a first LED **404-1**, a second LED **404-2**, and a third LED **404-3**, but is not so limited as the sensor **400** may comprise any number of LEDs **404**. The LEDs **404** may be of the same or different colors. For example, the first LED **404-1** may be of a first color (e.g., a green LED), the second LED **404-2** may be of a second color (e.g., an amber LED), and the third LED **404-3** may be of a third color (e.g., a red LED).

[0054] The LEDs **404** may provide a variety of functions during installation or during operation after installation of the sensor **400**. For example, during installation, the sensor **400** may be installed on a door by an installer. In a first mode of operation (e.g., in a default mode of operation when the sensor **400** is initially turned on), the LEDs **404** may illuminate (e.g., activate) to indicate a strength of a signal received from a controller (e.g., the remote controller **304**). The sensor **400** and a corresponding controller may be wirelessly coupled and/or paired during installation. The controller may send a signal (e.g., a wireless signal) to the sensor **400**. The sensor **400** may measure a power of the received signal. Based on the measured power or strength of the received signal, the sensor **400** may illuminate one or more LEDs **404** to indicate the measured power or strength of the received signal.

[0055] Also or alternatively, the sensor **400** may measure a power of a received wireless signal from a remote controller and may compare the measured power to a first measured signal power threshold and a second measured power threshold. The first measured power threshold may be greater than the second measured power threshold. The first measured power threshold and the second measured power threshold may be expressed in any unit of measure including, for example, Watts (W), milliwatts (mW), or decibel-milliwatts (dBm).

[0056] If the measured power of the received signal does not satisfy the second measured power threshold (e.g., is less than, or less than or equal to, a signal power associated with the second measured power threshold), the sensor **400** may illuminate the third LED **404-3**. Illumination of the third LED **404-3** may indicate that a relatively weak signal was received from the remote controller. This may indicate a need (e.g., which may inform the installer) to adjust a position or location of the sensor **400** (and/or of the remote controller) to improve the strength of signals the sensor **400** may receive from the remote controller.

[0057] If the measured power of the received signal satisfies the first measured power threshold (e.g., is greater than, or greater than or equal to, a signal power associated with the first measured power threshold), the sensor **400** may illuminate the first LED **404-1**. Illumination of the first LED **404-1** may indicate that a relatively strong signal was received from the remote controller. This may indicate (e.g., which may inform the installer) that the sensor **400** is in a position or location capable of receiving strong signals from the remote controller such that the position of the sensor **400** may not need to be moved to communicate with the remote controller.

[0058] If the measured power of the received signal satisfies the second measured power threshold (e.g., is greater than, or greater than or equal to, a signal power associated with the second measured power threshold) and does not satisfy the first measured power threshold (e.g., is less than, or less than or equal to, a signal power associated with the first measured power threshold), the sensor **400** may illuminate the second LED **404-2**. Illumination of the second LED **404-2** may indicate that a signal of intermediate signal strength (e.g., relative to a relatively weak signal strength and a relative strong signal strength) was received from the remote controller. This may indicate (e.g., which may inform the installer) that the sensor **400** is capable of communicating with the remote controller but that further adjustment to the position of the sensor **400** may improve the strength of the signals the sensor may receive from the remote controller.

[0059] In a second mode of operation (e.g., in a mode of operation after the first mode of operation described above), the LEDs **404** may illuminate to indicate a strength of a measured magnetic field. The sensor **400** may be positioned during installation in relatively close proximity to a corresponding magnet. For example, the sensor **400** may be installed onto a door. A corresponding magnet may be installed in relatively close proximity to the sensor **400** (e.g., if the door is closed) on a door frame. During the second mode of operation of the sensor **400**, the sensor **400** may measure a strength of a detected magnetic field based on the corresponding magnet. Based on the measured power or strength of the magnetic field, the sensor **400** may illuminate one or more LEDs **404** to indicate the measured strength of the magnetic field.

[0060] An installer may cause the sensor **400** to switch (e.g., transition) to the second mode of operation in a variety of manners. As a first example, the cover **402** may be closed (e.g., relative to a base of the sensor **400**) from an open position to cause the sensor **400** to enter the second mode of operation. As a second example, the installer may engage (e.g., press) the button **406** (e.g., toggle button) to cause the sensor **400** to enter the second mode of operation.

[0061] Once the sensor **400** operates within the second mode of operation, the sensor **400** may illuminate the LEDs **400** based on a strength of the measured magnetic field. For example, the installer may close the door such that the sensor **400** is in relatively close proximity to a corresponding magnet positioned on a door frame. The sensor **400** may measure a strength of the magnetic field and may compare the measured strength to a first measured magnetic field strength threshold and a second measured magnetic field strength threshold. The first measured magnetic field strength threshold may be greater than the second measured magnetic field strength threshold. The first measured mag-

netic field strength threshold and the second measured magnetic field strength threshold may be expressed in any unit of measure including, for example, Tesla (T) or milliTesla (mT).

[0062] If the measured strength of the magnetic field does not satisfy the second measured magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the second measured magnetic field strength threshold), the sensor **400** may illuminate the third LED **404-3**. Illumination of the third LED **404-3** may indicate that a relatively weak magnetic field strength was measured by the sensor **400**. This may inform the installer to adjust a position or location of the sensor **400** and/or the magnet to improve the strength of magnetic field the sensor **400** may measure when the door is closed.

[0063] If the measured strength of the magnetic field satisfies the first measured magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the first measured magnetic field strength threshold), the sensor **400** may illuminate the first LED **404-1**. Illumination of the first LED **404-1** may indicate that a relatively strong magnetic field strength was measured by the sensor **400**. This may inform the installer that the position of the sensor **400** and the magnet are suitable for correctly detecting if the door is closed.

[0064] If the measured strength of the magnetic field satisfies the second measured magnetic field strength threshold (e.g., is greater than, or greater than or equal to a magnetic field strength associated with the second measured magnetic field strength threshold) and does not satisfy the first measured magnetic field strength threshold (e.g., is less than, or less than or equal to a magnetic field strength associated with the first measured magnetic field strength threshold), the sensor **400** may illuminate the second LED **404-2**. Illumination of the second LED **404-2** may indicate an intermediate strength of the magnetic field was measured (e.g., relative to a relatively weak measured magnetic field and a relative strong measured magnetic field strength). This may inform the installer that further adjustments to a position or location of the sensor **400** and/or the magnet may be useful to improve the strength of magnetic field the sensor **400** may measure if the door is closed.

[0065] The sensor **400** may operate to compare the measured strength of the magnetic field to any number of thresholds. Further, the sensor **400** may alternatively use a separate set of LEDs (e.g., one or more LEDs) to indicate a strength of a measured magnetic field.

[0066] In a third mode of operation, the sensor **400** may measure a strength of a magnetic field (e.g., based on the relative positions of the sensor **400** and a corresponding magnet) and may report the measured strengths of the magnetic field to an associated remote controller (e.g., the remote controller **304**). The sensor **400** may measure and report the strength of the magnetic field according to any desired interval or frequency. For example, the sensor **400** may measure and report the strength of the magnetic field periodically according to a period of time set by a user (e.g., a user of the user device **306**).

[0067] An installer may cause the sensor **400** to switch to the third mode of operation in a variety of manners. As a first example, the cover **402** may be closed (e.g., relative to a base of the sensor **400**) from an open position to cause the sensor **400** to enter the third mode of operation. As a second example, the installer may engage (e.g., press) the button **406** to cause the sensor to enter the third mode of operation. An installer may cause the sensor **400** to enter the third mode of operation after determining that the sensor **400** is receiving a relatively strong signal from the remote controller (e.g., as determined during the first mode of operation) and/or after determining that the sensor **400** is measuring a relatively strong magnetic field if the door is closed (e.g., as determined during the second mode of operation). The third mode of operation for the sensor **400** may be a steady-state mode of operation for the sensor.

[0068] During the third mode of operation, the sensor **400** may generate and transmit a reporting signal or message to the remote controller after each measurement of the strength of the magnetic field. The reporting signal may indicate a strength of the measured magnetic field. The reporting signal may comprise other indications as well including, for example, an indication of a received signal strength from the remote controller (e.g., an average received signal strength or a signal strength of a most recently received signal from the remote controller). The reporting signal may also comprise other indications such as temperature measurements.

[0069] The remote controller may compare the indications of measured magnetic field strength from the sensor **400** to one or more thresholds. For example, the remote controller may compare the indications of measured magnetic field strength from the sensor **400** to a measured magnetic field strength threshold. If an indication of a measured magnetic field strength from the sensor satisfies the measured magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the measured magnetic field strength threshold), the remote controller may determine that the door is closed. If an indication of a measured magnetic field strength from the sensor does not satisfy the measured magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the measured magnetic field strength threshold), the remote controller may determine that the door is open.

[0070] The measured magnetic field strength threshold (alarm threshold) may be stored by the remote controller. The measured magnetic field strength threshold may be set or determined based on measurements made by the sensor **400** during the second mode of operation. For example, during the second mode of operation, the sensor **400** may report one or more measurements of the strength of the magnetic field detected by the sensor **400** when the door is closed. The remote controller may use the one or more measurements to set the measured magnetic field strength threshold. The measured magnetic field strength threshold may be set to be lower than the one or more measurements. For example, the measured magnetic field strength threshold may be set to be a certain percentage lower than the one or more measurements (e.g., 30% lower). As another example, the measured magnetic field strength threshold may be set to be a certain level lower than the one or more measurements (e.g., 5 mT lower than an average of the one or more measurements).

[0071] As a further example, the sensor **400** during the second mode of operation may provide one or more first measurements indicating a strength of the magnetic field when the door is closed and may provide one or more second measurements indicating a strength of the magnetic field when the door is open. The remote controller may use the

one or more first measurements and/or the one or more second measurements to set one or more measured magnetic field strength thresholds.

[0072] A measured magnetic field strength threshold may be initially set or determined during installation of the sensor **400**. Over time, during the third mode of operation, a position of the sensor **400** and/or its corresponding magnet may change. For example, as the door is repeatedly used, an initial positioning of the sensor **400** on the door may be altered, thereby adjusting an orientation and/or alignment of the sensor **400** relative to the corresponding magnet positioned on the door frame. This may affect measurements of the strength of the magnetic field by the sensor **400** when the door is closed or when the door is open. For example, due to a change in alignment between the sensor **400** and the corresponding magnetic, the sensor **400** may measure a relatively lower strength of the magnetic field if the door is closed after extended use as compared to a relatively higher strength of the magnetic field if the door is closed when the sensor is first installed.

[0073] With respect to a particular example, the sensor **400** at the time of installation may measure the strength of the magnetic field when the door is closed to be 18 mT. The remote controller may set the measured magnetic field strength threshold to be 10 mT based on this measurement. At a later time (e.g., months after installing the sensor **400**), the sensor **400** may measure the strength of the magnetic field when the door is closed to be 14 mT. In response to the sensor **400** measuring a lower strength of the magnetic field when the door is closed relative to the strength of the magnetic field measured at the time of installation, the remote controller may adjust the measured magnetic field strength threshold. For example, the remote controller may reduce or decrease the measured magnetic field strength threshold to 9 mT. In doing so, the remote controller may avoid false alarm reporting—for example, the remote controller may avoid or may reduce a likelihood of incorrectly determining that the door is open if in fact the door is closed, based on the changed orientation of the sensor **400** and the magnet.

[0074] The remote controller may use any number of thresholds to determine if the door is open, closed, or in partially closed or partially open state. Any of these thresholds may be adjusted by the remote controller based on any measurements of the magnetic field strength by the sensor **400**. The remote controller may adjust any threshold based on any measurements of the magnetic field strength received from the sensor **400** over any period of time. For example, the measured magnetic field strength threshold may be adjusted to be lower if the reported measurements from the sensor **400** are lower than an initial reported measurement (e.g., during installation) for a certain period of time. The reported measurements may be lower based on a direct comparison of measured values or based on a percentage change of the reported measurements compared to the initial measurement.

[0075] The initial measurement may be an average of two or more measurements made by the sensor determined at the time of installation. Alternatively, the initial measurement may be a single measurement made at the time of installation. An installer may designate a measurement (or set of measurements, or average of a set of measurements) made by the sensor **400** at the time of installation to be the initial measurement. The initial measurement may be a maximum reported measured value from the sensor. The initial measurement may be designated for comparison purposes at a later time for adjusting any threshold such as, for example, the measured magnetic field strength threshold.

[0076] Any measurement made during the third mode of operation may be used to compare to the initial measurement. During the third mode of operation, any set or sequence of measurements, or any averaging of any number of measurements, may be used to compare to the initial measurement to determine if any threshold should be increased or decreased. For example, the remote controller may adjust the measured magnetic field strength threshold based on a certain number of current measurements being lower or being higher than the initial measurement by a certain amount (e.g., by a specified magnetic field strength change or difference). The certain number of current measurements may be predetermined, may be a number of measurements threshold, and/or may be set by the installer and/or the user of the user device **306**. The certain amount of change in the measurements may be predetermined, may be a measurement change threshold, and/or may be set by the installer and/or the user of the user device **306**. The measurement change threshold may be a certain measurement value change (e.g., expressed as a change in magnitude of the measured magnetic field strength such as 3 mT) or may be expressed as a change in percentage (e.g., relative to the intimal measurement such as 15% lower or higher than the initial measurement). In this manner, if the sensor consistently reports lower measured strength of the magnetic field if the door is closed as compared to when the sensor **400** was initially installed, thresholds used for determining a security event—for example, whether the door is open or closed—may be adjusted to account for changes in the position and orientation of the sensor **400** and the magnet. By dynamically adjusting the thresholds based on changes to the reported measurements over time, the likelihood that the door will be determined to be open based on a relatively low measurement made by the sensor **400** if the door is actually closed will be reduced. Similarly, if the sensor consistently reports increased measured strength of the magnetic field if the door is closed as compared to when the sensor **400** was initially installed, thresholds used for determining a security event—for example, whether the door is open or closed—may be adjusted (e.g., increased) to account for changes in the position and orientation of the sensor **400** and the magnet. By dynamically adjusting the thresholds based on changes to the reported measurements over time, the likelihood that the door will be determined to be closed based on a relatively high measurement made by the sensor **400** if the door is actually open will be reduced.

[0077] For example, the measured magnetic field strength threshold may be initially set based on initial measurements of the magnetic field made by the sensor **400** when the door is closed. Ata later time, measurements of the magnetic field made by the sensor **400** when the door is closed may be consistently lower than the initial measurements. The sensor **400** (or the remote controller) may lower the measured magnetic field strength threshold based on the later measurements indicating a lower magnetic field strength than the initial measurements. The threshold may be lowered based on the later measurements still satisfying the original threshold (e.g., meeting or exceeding the original threshold) by a predetermined amount or by a predetermined threshold.

[0078] Further, sensor **400** may be commanded via an instruction from the remote controller to operate in a lower power mode. The remote controller may determine that measurements of the magnetic field strength when the door is closed consistently satisfy an initial measured magnetic field strength threshold (e.g., are greater than, or greater than or equal to a magnetic field strength associated with an initial measured magnetic field strength threshold) by a predetermined amount or predetermined threshold. As such, the remote controller may determine that the sensor **400** and magnet are well positioned and oriented to provide reliable measurements of the magnetic field if the door is closed. In turn, the remote controller may send the sensor **400** a command to enter into a lower power mode or low power operating mode to conserve battery resources. In the low power mode, one or more bias currents of the sensor **400** may be lowered to reduce power consumption. The one or more bias currents of the sensor **400** may be lowered without affecting the accuracy of the magnetic field measurements made by the sensor **400**.

[0079] The sensor **400** may be integrated with the remote controller to form a combined sensor-controller device (e.g., the sensor may be part of the controller). The sensor **400** may also store any magnetic field strength measurement thresholds and may compare any measured magnetic field strength value to the one or more stored thresholds.

[0080] FIG. **4**B shows an example installation of the sensor **400**. As shown in FIG. **4**B, the sensor **400** may be attached (e.g., connected or coupled) to a door **408**. A magnet **410** may be attached (e.g., connected or coupled) to a door frame **412**. The sensor **400** may be attached in relatively close proximity to an edge or corner of the door **408**. The magnet **410** may be attached to the door frame **412** in relatively close proximity to an edge or corner of the door **408**. FIG. **4**B shows the door **408** in a closed positioned such that the sensor **400** is in relatively close proximity to the magnet **410**. As such, the sensor **400** may detect a relatively strong magnetic field from the magnet **410**. Alternatively, the sensor **400** may be attached to the door frame **412** and the magnet **410** may be attached to the door **408**.

[0081] FIGS. **5**A and **5**B are a flow chart showing steps of an example method associated with monitoring security events. One, some, or all steps of the example method of FIGS. **5**A and **5**B may be performed by any of the devices described herein (e.g., the sensor **302**, the sensor **400**, the remote controller **304**, the security monitor server **140**, the user device **306**, and/or an integrated sensor **302** or sensor **400** and remote controller **304**). Also or alternatively, one, some, or all steps of the example method of FIGS. **5**A and **5**B may be performed by one or more other devices, including any of the computing devices described herein. Steps of the example method of FIGS. **5**A and **5**B may be omitted, performed in other orders, and/or otherwise modified, and/or one or more additional steps may be added.

[0082] The method may start in step **502**. In step **502**, a sensor may enter a first mode of operation. The sensor may be the sensor **302**. The sensor may enter the first mode of operation by default. For example, the sensor may be powered up or turned on in step **502** and may be configured to automatically enter the first mode of operation. In the first mode of operation, the sensor may be configured to receive a signal from a remote controller (e.g., the remote controller **304**), measure a power of the received signal, and to send a signal or message to the remote controller indicating a power of the received signal, as described further herein.

[0083] The sensor may enter the first mode of operation as a first phase of installing the sensor. For example, in step **502**, an installer may begin an installation process of the sensor. The installation process may involve positioning the sensor on an object that is to be monitored (e.g., a door) and ensuring the sensor can receive a signal from an associated remote controller.

[0084] In step **504**, the sensor may receive a signal from the remote controller. The signal may be any type of signal including, for example, a wired signal or a wireless signal. The signal may be transmitted and received over any communication network (e.g., the network **308**) and/or medium based any communication standard or protocol. The signal may be a signal generated and transmitted according to the Zigbee protocol (e.g., the signal may be a wireless Zigbee signal).

[0085] In step **506**, the sensor may measure a power of the received signal (e.g., determine a signal strength of the received signal). A technique or procedure implemented by the sensor to measure the power of the received signal may be known to the remote controller.

[0086] In step **508**, the sensor may illuminate one or more LEDs (e.g., the LEDs **404-1** through **404-3**) based on the measured power of the received signal. The sensor may compare the measured power of the received signal to one or more thresholds (e.g., signal power measurement thresholds) to determine one or more LEDs to illuminate to indicate the measured power of the received signal. Illumination of the LEDs may visually indicate to an individual (e.g., an installer) if the sensor is receiving a signal of adequate signal power from the remote controller. The LEDs may illuminate in a manner to indicate whether the sensor should be repositioned to attempt to receive a stronger signal from the remote controller or if the signal received from the remote controller is of adequate strength. The assessment as to whether the sensor is receiving a signal from the remote controller of an adequate strength may be made based a visual determination of which LEDs are illuminated.

[0087] The remote controller may send a test signal to the sensor during the first mode of operation of the sensor. The test signal may be transmitted periodically and/or continuously to provide a signal for the sensor to receive and to measure the power of the signal. The LEDs of the sensor may illuminate based on a most recently received and measured signal from the remote controller and may change illumination based on a next received and measured signal from the remote controller. The test signal from the remote controller may be transmitted once every minute for example.

[0088] In step **510**, the sufficiency of the strength of the received signal may be determined. The sensor may illuminate the first LED **404-1** if the signal being received by the sensor is of adequate strength. The sensor may send a message to the remote controller reporting the measured signal strength of a received signal from the remote controller. The remote controller may determine based on the received measured signal strength if the sensor is receiving signals at an adequate level of strength. The method may proceed to step **512** if the signal being received by the sensor is of adequate strength. Alternatively, the method may proceed to step **514** if the signal being received by the sensor

is not of adequate strength. For example, the method may proceed to step **514** if the third LED **404-3** is illuminated.

[0089] In step **514**, the sensor may be repositioned to improve a strength of the signal it may receive from the remote controller. For example, a change to a position or an alignment of the sensor on a door may be made so as to improve a wireless reception of a signal from the remote controller. Steps **504** through **510** may be repeated to determine if the signal from the remote controller is now (e.g., after repositioning) being received at an adequate power level by the repositioned sensor (e.g., based on one or more determinations made by the remote controller). In step **514**, the installer may engage an interface of the sensor (e.g., the button **406**) to reset the illumination of the LEDs and to cause the sensor to re-measure a signal from the remote controller. The sensor may also generate and transmit a signal or message to the remote controller reporting the measured strength of the received signal.

[0090] As mentioned above, in step **512**, the sensor may enter a second mode of operation. The sensor may enter the second mode of operation in a variety of manners. The installer may cause the sensor to enter the second mode of operation. For example, the installer may engage a feature of the sensor (e.g., the button **406**) to cause the sensor to transition from the first mode of operation to the second mode of operation.

[0091] In the second mode of operation, the sensor may be configured to measure a strength of a magnetic field. The magnetic field may be provided by a magnetic associated with the sensor. For example, a magnet positioned on an object (e.g., a door frame) near the object to which the sensor is attached (e.g., a door) may provide a magnetic field. The sensor may be configured to detect the magnetic field and to measure a strength of the magnetic field.

[0092] The sensor may enter the second mode of operation as a second phase of installing the sensor. For example, in step **512**, an installer may continue an installation process of the sensor. The second phase of the installation process may involve positioning the sensor on an object that is to be monitored (e.g., a door) and ensuring the sensor can detect and measure a strength of a magnetic field provided by a corresponding magnet.

[0093] The sensor may enter the second mode of operation automatically or manually. The sensor may be configured to automatically enter the second mode of operation based on a command received from the remote controller. The sensor may be configured to manually enter the second mode of operation based on the installer engaging a feature of the sensor. For example, the installer may engage a user interface feature (e.g., the button **406**) to cause the sensor to enter the second mode of operation.

[0094] In step **516**, the sensor may detect a magnetic field. The magnetic field may be provided by a magnet associated with the sensor (e.g., a paired magnet). The magnet may be positioned on a door frame or a window frame. The magnet may generate a magnetic field that the sensor may detect if the sensor is in relatively close proximity to the magnet. For example, in step **516**, the sensor may be attached to a door that is closed. The magnet that may be positioned on the door frame in relatively close proximity to the sensor. The sensor may therefore be in relatively close proximity to the magnet and may detect a magnetic field from the magnet.

[0095] In step **518**, the sensor may measure an intensity or strength of the magnetic field from the magnet (e.g., a flux density of the magnetic field). The sensor may comprise a magnetometer to measure the strength of the magnetic field. A technique or procedure implemented by the sensor to measure the strength of the magnetic field may be known to the remote controller. The measurement of the strength of the magnetic field may be a measurement of the strength of the magnetic field if the sensor is in close proximity to the magnet—for example, if the door is closed such that the measurement indicates a strength when the door is closed.

[0096] In step **520**, the sensor may illuminate one or more LEDs (e.g., the LEDs **404-1** through **404-3**) based on the measured strength of the detected magnetic field. The sensor may compare the measured strength of the magnetic field to one or more thresholds (e.g., magnetic strength measurement thresholds) to determine one or more LEDs to illuminate to indicate the measured strength of the magnetic field. Illumination of the LEDs may visually indicate to an individual (e.g., an installer) if the sensor is detecting a magnetic field of adequate strength from the magnet. The LEDs may illuminate in a manner to indicate whether the sensor should be repositioned to attempt to receive a stronger magnetic field from the magnet or if the magnetic field detected from the magnet is of adequate strength. The assessment as to whether the sensor is receiving a signal from the remote controller of an adequate strength may be made based a visual determination of which LEDs are illuminated.

[0097] In step **522**, the sufficiency of the strength of the magnetic field may be determined. The sensor may illuminate the first LED **404-1** if the magnetic field being detected by the sensor is of adequate strength. The sensor may send a message to the remote controller reporting the measured strength of the magnetic field. The remote controller may determine based on the received measured strength of the magnetic field if the sensor is detecting a magnetic field of sufficient strength. The method may proceed to step **526** if the strength of the magnetic field measured by the sensor is of adequate strength. Alternatively, the method may proceed to step **524** strength of the magnetic field measured by the sensor is not of adequate strength. For example, the method may proceed to step **524** if the third LED **404-3** is illuminated.

[0098] In one example, a first LED (e.g., green LED) of the sensor (the LED **404-1**) may illuminate if the measured strength of the magnetic field is 10 mT or greater; a second LED (e.g., amber LED) of the sensor (the LED **404-2**) may illuminate if the measured strength of the magnetic field is 7 mT or greater and less than 10 mT; and a third LED (e.g., red LED) of the sensor (the LED **404-3**) may illuminate if the measured strength of the magnetic field is less than 7 mT.

[0099] In step **524**, the sensor and/or the corresponding magnet may be repositioned to improve a strength of the magnetic field detected by the sensor. For example, a change to a position or an alignment of the sensor on a door may be made so as to improve detection of the magnetic field from the magnet. Steps **514** through **520** may be repeated to determine if the magnetic field from the magnet is now (e.g., after repositioning) being detected at an adequate level by the repositioned sensor (e.g., based on one or more determinations made by the remote controller). In step **524**, the installer may engage an interface of the sensor (e.g., the button **406**) to reset the illumination of the LEDs and to cause the sensor to re-measure a strength of the magnetic field from the magnet. As described herein, the sensor may also generate and transmit a signal or message to the remote

controller reporting the measured strength of the magnetic field so that the sufficiency of the strength of the measured magnetic field may be determined by the remote controller.

[0100] In step **526**, the sensor may enter a third mode of operation. The sensor may enter the third mode of operation in a variety of manners. The installer may cause the sensor to enter the third mode of operation. For example, the installer may engage a feature of the sensor (e.g., the button **406**) to cause the sensor to transition from the second mode of operation to the third mode of operation. The sensor may enter the third mode of operation based on a command from the remote controller.

[0101] In the third mode of operation, the sensor may be configured to operate in a steady-state or post-installation manner. In the third mode of operation, the sensor may be configured to perform a number of functions or operations including, for example, measure the strength of a signal received from the remote controller, measure the strength of the magnetic field from the magnet, receive and process commends or other signals from the remote controller, provide to the remote controller an indication of the measured received signal strength from the remote controller, and/or provide to the remote controller an indication of the measured magnetic field strength from the magnet. The sensor may also measure and provide indications of other detected or sensed environmental conditions. For example, the sensor may measure and report a sensed temperature during the third mode of operation.

[0102] The sensor may enter the third mode of operation after an installation of the sensor is completed. For example, in step **526**, it may be determined (e.g., by the remote controller) that the sensor is capable of receiving signals from the remote controller at an adequate power level and/or that the sensor is capable of detecting a magnetic field from the magnet at an adequate strength level if the sensor is in close proximity to the magnet (e.g., when the door is closed).

[0103] In step **528**, one or more thresholds may be set. The thresholds may be thresholds used for comparison to measured magnetic field strength measurements made by the sensor. The thresholds may be set by the sensor and/or the remote controller. The thresholds may be stored by the sensor and/or the remote controller. The thresholds may be used by the sensor and/or the remote controller to compare to any magnetic field strength measurement made by the sensor to determine if a security event has occurred—for example, to determine if a door to which the sensor is connected is closed or open.

[0104] The thresholds may comprise a first magnetic field strength threshold and a second magnetic field strength measurement. The first magnetic field strength threshold and the second magnetic field strength threshold may be represented in milliTeslas, mT. The first magnetic field strength threshold may be greater than the second magnetic field strength threshold. In one example, the first magnetic field strength threshold may be 1.540 mT and the second magnetic field strength threshold may be 0.94 mT.

[0105] The sensor and/or remote controller may operate in the following manner based on the first magnetic field strength threshold and the second magnetic field strength threshold. If a measured strength of a detected magnetic field from the magnet satisfies the first magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the first magnetic field strength threshold), the sensor and/or remote controller may determine that the sensor is in relatively close proximity to the magnet. As such, the sensor and/or remote controller may determine that the door to which the sensor is closed and/or that no security event (e.g., no alarm condition) is occurring. An indication that the door is closed may be provided by the sensor and/or the remote controller to a user device (e.g., the user device **306**) and/or to a remote server (e.g., the security server **140**). The indication may be a message that also comprises the measured strength of the magnetic field.

[0106] If a measured strength of a detected magnetic field from the magnet does not satisfy the second magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the second magnetic field strength threshold), the sensor and/or remote controller may determine that the sensor is not in relatively close proximity to the magnet. As such, the sensor and/or remote controller may determine that the door to which the sensor is attached is open and/or that a security event (e.g., an alarm condition) is occurring. An indication that the door is open may be provided by the sensor and/or the remote controller to a user device (e.g., the user device **306**) and/or to a remote server (e.g., the security server **140**). The indication may be a message that also comprises the measured strength of the magnetic field.

[0107] If a measured strength of a detected magnetic field from the magnet does not satisfy the first magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the first magnetic field strength threshold) and satisfies the second magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the second magnetic field strength threshold), the sensor and/or remote controller may determine that the sensor is not in relatively close proximity to the magnet but that the door is not entirely open. As such, the sensor and/or remote controller may determine that the door to which the sensor is attached is partially open and that no security event is occurring, unless the door remains partially open for some threshold amount of time. For example, the sensor and/or remote controller may determine that the door was opened and is being closed or is only partially opened, such that no security event is occurring but that a security event may occur if the door is not shut within a threshold period of time. An indication that the door is partially open may be provided by the sensor and/or the remote controller to a user device (e.g., the user device **306**) and/or to a remote server (e.g., the security server **140**). The indication may be a message that also comprises the measured strength of the magnetic field.

[0108] Alternatively, the sensor and/or remote controller may determine that a security event is occurring anytime the door is opened—for example, any time the strength of the measured magnetic field does not satisfy the first magnetic field (e.g., is less than, or less than or equal to, a magnetic field strength associated with the first magnetic field strength threshold), and/or any time the strength of the measured magnetic field does not satisfy the first magnetic field but does satisfy the second magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the second magnetic field strength threshold). The sensor and/or remote controller may also operate to provide an indication any time that the strength of the magnetic field as measured by the sensor

changes by a certain amount. For example, if the strength of the magnetic field changes by a threshold amount (e.g., by a magnetic field strength threshold amount) compared to a prior measurement or set of measurements, the sensor and/or remote controller may provide a corresponding indication. This enables tracking of situations where a door may be partially opened even though the measured strength of the magnetic field satisfies (e.g., is greater than, or greater than or equal to) the second magnetic field strength threshold.

[0109] In the third mode of operation, the sensor may be configured to send a signal reporting any measured magnetic field strength to the remote controller. The signal may be generated and transmitted periodically. The signal may indicate a strength of the measured magnetic field. The signal may comprise other parameters or features as described herein. For example, the signal may comprise an indication of a measured temperature and/or an indication of a measured power of a signal received from the remote controller.

[0110] The sensor and/or the remote controller may compare any magnetic field measurement made by the sensor to the one or more magnetic field strength thresholds. If the sensor is configured to compare a magnetic field measurement to a magnetic field threshold, the sensor may report an outcome or result of the comparison to the remote controller. For example, if the sensor measures the magnetic field strength as satisfying the first magnetic field strength threshold (e.g., to be greater than, or greater than or equal to a magnetic field strength associated with the first magnetic field strength threshold), the sensor may generate and transmit a signal to the remote controller indicating the same.

[0111] The thresholds set in step **528** may be set in any manner. The thresholds may be set by the remote controller based on measurements reported by the sensor during the second mode of operation. Alternatively or additionally, the thresholds may be set based on magnetic field strength measurements made by the sensor in step **528**. One or more magnetic field measurements made by the sensor when the door is closed (e.g., as verified or ensured by the installer) may be used to set any threshold value. For example, during the second mode of operation, the installer may cause the door to be closed and for the sensor to detect and report the measured magnetic field strength if the door is closed. The strength of the magnetic field reported may be used to set one or more thresholds. An average of one or more measurements may also be used to set any threshold. An input provided to the sensor and/or the remote controller (e.g., by an installer or a user) may indicate that a particular strength measurement is a measurement of the magnetic field when the door is closed. This particular strength measurement may then be used (e.g., by the remote controller) to set one or more thresholds (e.g., alarm threshold or security event threhsolds0 as described herein.

[0112] In step **530**, the sensor may detect and measure the magnetic field from the magnet. In step **532**, the sensor may compare the measured magnetic field strength (e.g., from step **530**) to the first magnetic field strength threshold. If the measured magnetic field strength satisfies the first magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the first magnetic field strength threshold), the method may proceed to step **534**. If the measured magnetic field strength does not satisfy the first magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the first magnetic field strength threshold), the method may proceed to step **538**.

[0113] In step **534**, the sensor may generate and send a message to the remote controller. The message may indicate that the sensor has determined that the measured magnetic field strength satisfies the first magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the first magnetic field strength threshold). The message may also indicate a value of the measured magnetic field strength. The sensor and/or the remote controller, based on the measured magnetic field strength satisfying the first magnetic field strength threshold (e.g., being greater than, or greater than or equal to a magnetic field strength associated with the first magnetic field strength threshold), may determine that the door is closed. As such, the sensor and/or the remote controller may determine that no security event is occurring with respect to the door. An indication of no security even being detected may be provided by the sensor and/or the remote controller to a user device (e.g., the user device **306**) or a remote server (e.g., the security monitor server **141**).

[0114] In step **536**, the sensor, the remote controller, the user device, and/or the remote server may determine any changes to the measured magnetic field experienced over time. For example, any changes or trends (e.g., any change in magnitude or rate of change) related to the magnetic field as measured over any period of time may be determined. Any determination as to any change or trend related to the magnetic field determined in step **536** may be used to determine in step **537** whether to adjust one or more thresholds used for comparison. The first magnetic field strength threshold and/or the second magnetic field strength threshold may be modified or changed in step **528**.

[0115] The sensor, the remote controller, the user device, and/or the remote server may make the determination in step **537** to adjust one or more thresholds based on any determination made in step **536**. For example, in step **536**, it may be determined that a strength of the magnetic field is trending lower (e.g., is decreasing over time). In step **537**, it may be determined that the first magnetic field strength threshold and/or the second magnetic field strength threshold may be modified or changed, based on the rate of change of the magnetic field meeting or exceeding a predetermined rate of change. In other words, if the rate of change of the strength of the measured magnetic field (e.g., as determined in step **536**), is determined to meet or exceed the predetermined rate of change (e.g., as determined in step **537**), then the method may proceed to step **528** for modification of one or more thresholds.

[0116] For example, based on one or more determinations made in step **536**, the first magnetic field strength threshold may be determined to be modified to be increased or decreased in step **537** and the first magnetic field strength threshold may be modified (e.g., increased or decreased) in step **528**. The first magnetic field strength threshold may be modified based on determining a trend in measurements made by the sensor of the detected magnetic field if the door is closed. For example, a trend in measurements made by the sensor of the detected magnetic field if the door is closed may be determined in step **536** to indicate that the detected magnetic field strength has decreased (e.g., relative to some initial or original detected magnetic field strength). As a result, the first magnetic field strength threshold and/or the second magnetic field strength threshold may be determined

to be lowered in step **537** (and correspondingly lowered in step **528**) based on, for example, the decrease in the magnetic field strength meeting or exceeding a predetermined value and/or a predetermined rate of change. Similarly, a trend in measurements made by the sensor of the detected magnetic field if the door is closed may be determined in step **536** to indicate that the detected magnetic field strength has increased (e.g., relative to some initial or original detected magnetic field strength). As a result, the first magnetic field strength threshold and/or the second magnetic field strength threshold may be determined to be increased in step **537** (and correspondingly increased in step **528**) based on, for example, the increase in the magnetic field strength meeting or exceeding a predetermined value and/or a predetermined rate of change.

[0117] In step **536**, any number of magnetic field strength measurements made over any period of time may be compared to any number of initial or first magnetic field strength measurements. The initial magnetic field strength measurements may be made during any time during operation of the sensor. Magnetic field strength measurements made subsequent to the initial magnetic field strength measurements may be compared to a lowest initial magnetic field strength measurement, a highest initial magnetic field strength measurement, and/or an average initial magnetic field strength measurement to determine any increasing or decreasing trend in the strength of the magnetic field.

[0118] Accordingly, in steps **536-537**, the remote controller may determine that recent measurements made by the sensor when the sensor is in close proximity to the magnet (e.g., if the door is closed) indicate a lower measured magnetic field strength as compared to a strength of the magnetic field as measured by the sensor earlier in time (e.g., during the second mode of operation). The lower strength of the measured magnetic field may indicate that the sensor and/or the magnet have been moved from their original installation positions, thereby reducing a strength of the magnetic field measured by the sensor from the magnet if the door is closed. The remote controller may determine that the strength of the magnetic field as measured by the sensor if the door is closed still satisfies the first magnetic field strength threshold (e.g., meets or exceeds the first magnetic field strength threshold); however, the remote controller may determine that the first magnetic field strength threshold should be lowered, to reflect the settling or change in positioning of the sensor and/or the magnet, to avoid any false alarm reporting.

[0119] The first magnetic field strength threshold may be determined in step **537** to be adjusted in any manner based on an any measurements made by the sensor—for example, based on comparison of any detected change or trend of the strength of the magnetic field to one or more predetermined magnetic field strength values (e.g., magnitudes) and/or one or more predetermined magnetic field rates of change. As a first example, in step **537**, the first magnetic field strength threshold may be determined to be reduced to a lower value based on a determination, in step **536**, that a certain number of magnetic field measurements made by the sensor are lower than an initial or benchmark magnetic field strength value. The number of measurements used for evaluation in step **536** may be a sequential number of measurements and may be any number of measurements. As a second example, in step **537**, the first magnetic field strength threshold may be determined to be reduced to a lower value based on a determination, in step **536**, that the sensor is measuring the magnetic field to be lower than the initial or benchmark magnetic field strength value for a certain amount of time. The amount of time may be any amount of time. As a third example, in step **537**, the magnetic field strength threshold may be determined to be reduced to a lower value based on a determination, in step **536**, that the sensor is measuring the magnetic field to be lower than the initial or benchmark magnetic field strength value by a certain amount. That is, in step **536**, if it is determined that measurement values drop below a certain threshold compared to the initial or benchmark magnetic field strength value, then in step **537** it may be determined that the threshold may be lowered regardless of how many measurements at the lower value were made or what period of time has elapsed. In general, any one or more factors relating to time, measured strength, and frequency of lower measurements may influence whether to lower the threshold. Further, the first magnetic field strength threshold may be reduced by a certain amount (e.g., a certain value or magnitude) or the first magnetic field strength threshold may be reduced by a certain percentage of the initial or benchmark magnetic field strength value.

[0120] The initial or benchmark magnetic field measurement relied on in step **536** may be based on a prior measurement or set of measurements made by the sensor and used to establish a benchmark measurement. For example, one or more measurements made by the sensor during the second mode of operation may be used in step **536** to determine the benchmark magnetic field measurement. As another example, one or more measurements made by the sensor during the third mode of operation may be used in step **536** to determine the benchmark magnetic field measurement. Multiple measurements may be averaged to form the benchmark magnetic field measurement. A maximum value or a median value of one or more measurements may be used to determine the benchmark magnetic field measurement.

[0121] For example, a first set of measurements of the strength of the magnetic field may be made by the sensor. The first set of measurements may comprise two or more measurements. The first set of measurements may be made when the door is closed and may be made if the sensor is operating in the second mode of operation or the third mode of operation. The first set of measurements may be averaged to generate an average measurement of the strength of the magnetic field when the door is closed. The first magnetic field strength threshold may be set to be a first amount less than the average measurement of the strength of the magnetic field. The first amount may be any value or any portion of the average measurement of the strength of the magnetic field. The sensor may operate for a period of time based on the first magnetic field strength threshold set in this manner. After a period of time, a second set of measurements may be averaged to generate a second average measurement of the strength of the magnetic field when the door is closed. In step **536**, the first set of measurements and the second set of measurements may be compared. Results of any comparison may be evaluated in step **537**. The second average measurement of the strength of the magnetic field may be less than the initial or first average measurement of the strength of the magnetic field. If the second average measurement of the strength of the magnetic field is lower than the first average measurement of the strength of the magnetic field by a predetermined threshold (e.g., an average measurement

change threshold), then in step **537** the first magnetic field strength threshold may be determined to be modified based on the second average measurement of the strength of the magnetic field determined in step **536**. For example, the first magnetic field strength threshold may be determined to be set to be lower than the second average measurement of the strength of the magnetic field by the first amount. In this manner, the first magnetic field strength threshold may be dynamically modified (e.g., via steps **536**, **537**, and **528**) to account for slight variations in the positioning and/or orientation of the sensor after extended use. If the second average measurement of the strength of the magnetic field is lower than the first average measurement of the strength of the magnetic field by a second predetermined threshold (e.g., an alert threshold), the sensor and/or remote controller may provide an indication that the sensor may be incorrectly installed or requires attention. The alert threshold may be set to any amount and may be set so as to reflect that the average measurement is now so low that it likely indicates a flaw in the positioning of the sensor.

[0122] If the evaluation of step **537** concludes that a threshold should be adjusted (e.g., the first magnetic field strength threshold), the method may proceed to step **528** as shown. In step **528**, one or more thresholds used by the sensor and/or the remote controller may be adjusted or modified in any manner. If the evaluation of step **537** concludes that a threshold should not be adjusted (e.g., the first magnetic field strength threshold), the method may proceed to step **530** as shown. In this manner, operation in the third mode of operation continues as the sensor is repeatedly operating to determine if a security event is occurring (e.g., to determine if the door is opened).

[0123] Proceeding to step **528** may allow the remote controller to modify one or more thresholds. The remote controller may send a message to a user device indicating a need to adjust one or more thresholds. The message may indicate that the sensor may be malfunctioning and/or requires inspection or attention. The message may be a reporting message that requests approval to modify one or more thresholds and/or that provides an alert regarding a potential or possible problem with the Hall effect sensor and/or the corresponding magnet. The alert may indicate or may be interpreted as indicating that there is a potential problem with the Hall effect sensor and/or the corresponding magnet such as, for example, that there has been a change in an alignment or a positioning of the Hall effect sensor and/or the corresponding magnet which may have caused the Hall effect sensor to measure lower strengths of the magnetic field (e.g., when a door is closed).

[0124] The remote controller may modify one or more thresholds automatically or may adjust one or more thresholds responsive to a user input (e.g., issued via a user interface of a user device). The user input may be a command or instruction specifying one or more values to use for the corresponding one or more thresholds to adjust. The user input may be a command or instruction specifying that modification of the one or more thresholds is allowable or approved by the user (e.g., that the request to reduce one or more thresholds is approved). For example, the remote controller may send a message to the user device indicating a need to adjust a threshold value and may provide a suggested modified threshold value. The message may request approval to reduce the threshold value. The user device, based on an input from the user, may issue a reply message indicating approval of the modification to the threshold value.

[0125] The remote controller may adjust a first threshold to generate a second threshold. The second threshold may be set to be a predetermined amount less than a lowest measured strength of one or more measured strengths of the magnetic field made by the sensor that the remote controller used to determine a reduction in a strength of the magnetic field. Alternatively, the second threshold may be set to be a predetermined amount less than an average measured strength of one or more measured strengths of the magnetic field made by the sensor that the remote controller used to determine a reduction in a strength of the magnetic field.

[0126] The remote controller may send one or more messages to the user device indicating any determined reduction in the strength of the magnetic field and/or any determined downward trend in the strength of the magnetic field. The remote controller may send a message indicating a false alarm condition if a measured strength of the magnetic field does not satisfy an initial alarm threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with an initial alarm threshold) and if the remote controller has determined a reduction in a strength of the magnetic field. As the remote controller has determined that an installation of the sensor and/or the magnet likely requires adjustment, based on determining the reduction in the strength of the magnetic field, the remote controller may avoid issuing an alarm condition when a subsequent measurement does not satisfy the initial alarm threshold (e.g., is less than, or less than or equal to a magnetic field strength associated with the initial alarm threshold) before the initial alarm threshold has been modified. Instead, the remote controller may send a message to the user device that a false alarm condition is occurring which may trigger the user to adjust a positioning of the sensor and/or the magnet (e.g., if a subsequent measured strength of the magnetic field is determined to be below the initial alarm threshold but above the modified alarm threshold). The message indicating the false alarm condition may also inform the user that a security event is not occurring (e.g., a door is closed although a measured strength of the magnetic field may falsely indicate the door is open).

[0127] As previously mentioned, the method may proceed to step **538** if it is determined in step **532** that the measured strength of the magnetic field does not satisfy the first magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the first magnetic field strength threshold). In step **538**, the sensor may compare the measured magnetic field strength (e.g., from step **530**) to the second magnetic field strength threshold. If the measured magnetic field strength does not satisfy the second magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the second magnetic field strength threshold), the method may proceed to step **540**. If the measured magnetic field strength does satisfy the second magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the second magnetic field strength threshold), the method may proceed to step **544**.

[0128] In step **540**, the sensor may generate and send a message to the remote controller. The message may indicate that the sensor has determined that the measured magnetic

field strength does not satisfy the second magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic field strength associated with the second magnetic field strength threshold). The message may also indicate a value of the measured magnetic field strength. The sensor and/or the remote controller, based on the measured magnetic field strength not satisfying the second magnetic field strength threshold (e.g., being less than, or less than or equal to, a magnetic field strength associated with the second magnetic field strength threshold), may determine that the door is open. As such, the sensor and/or the remote controller may determine that a security event is occurring with respect to the door. An indication of the security event being detected may be provided by the sensor and/or the remote controller to the user device (e.g., the user device **306**) and/or a remote server (e.g., the security monitor server **140**).

[0129] The sensor and/or the remote controller in step **540** may provide a variety of indications of the determined security event with respect to the door. The sensor and/or the remote controller may provide one or more visual, audible, or tactile alerts that may be noticed by an individual. For example, the sensor may illuminate one or more LEDs **404**. The sensor and/or the remote controller may also send one or more messages to the user device (e.g., the user device **306**) to alert a user as to the detected security event. The one or more messages may indicate which door is determined to be open. The one or more messages may also indicate additional information such as for how long the door has been determined to be opened (e.g., based on one or more measurements of the magnetic field strength being determined to be less than the second magnetic field strength threshold).

[0130] The sensor and/or the remote controller may continue to measure the strength of the magnetic field in step **540** to determine if the door remains opens or if the door is closed. For example, the sensor may periodically remeasure the strength of the magnetic field while in step **540** and may compare any new measurement to the first magnetic field strength threshold or the second magnetic field strength threshold.

[0131] The method may proceed to step **542** if the sensor and/or the remote controller determine that the security event detected and/or reported in step **540** has been cleared. The security event may be cleared in a number of manners. For example, a user of the user device may clear the security event determined in step **540**. The user may clear the security event, for example, if the user authorized the door being opened or is aware of someone using the door. The door may be a backdoor that is normally kept closed. A handy man may use the backdoor to service the house in a manner that the owner of the house authorizes and is aware. As such, if the security event of the backdoor is reported to the user via the user device, the user may make note of the alert and dismiss and/or clear it, such that the method proceeds to step **542**. In step **542**, a record or log of the security event and its clearance may be stored.

[0132] As another example of clearing the security event, the sensor may continue to measure the detected magnetic field and may determine the security event is over (e.g., the door is closed) if the sensor measures a magnetic field strength that satisfies the first magnetic field strength threshold (e.g., is greater than, or greater than or equal to a magnetic field strength associated with the first magnetic field strength threshold). Based on a subsequent measurement of the magnetic field strength being determined to satisfy the first magnetic field strength threshold (e.g., greater than, or greater than or equal to, a magnetic field strength associated with the first magnetic field strength threshold), the sensor and/or the remote controller may determine the door has been closed such that the security event is over or resolved. The sensor and/or the remote controller may generate and send a message to the user device indicating the clearance of the security event (e.g., including a reason why the event has been cleared). The sensor and/or the remote controller may determine the door is closed based on a single subsequent measurement satisfying the first magnetic field strength threshold (e.g., meeting or exceeding the first magnetic field strength threshold). Alternatively, the sensor and/or the remote controller may determine the door is closed based on a certain number of subsequent measurements (e.g., sequential measurements) satisfying the first magnetic field strength threshold (e.g., meeting or exceeding the first magnetic field strength threshold).

[0133] Once the security event is cleared, the method may proceed from step **542** to step **530** for the sensor to continue operating to detect, measure, and report the strength of the magnetic field to determine a status of the door.

[0134] If it is determined in step **538** that the measured strength of the magnetic field satisfies the second magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the second magnetic field strength threshold), the sensor and/or the remote controller may determine that the door is partially opened and/or may be in a process of being used (e.g., may be being opened or may be being closed). As such, the sensor and/or the remote controller may not determine that a security event is occurring. The sensor and/or the remote controller may generate and send a message to the user device indicating the determination of step **544**. The message may indicate a value of the measured magnetic field strength.

[0135] The sensor and/or the remote controller may determine a security event is not occurring in step **544** based on prior configuration of the sensor and/or the remote controller. For example, the user of the user device may specify that only if the door is likely fully open should a security event be determined. As such, measurements that satisfy the second magnetic field strength threshold (e.g., meet or exceed the second magnetic field measurement threshold) may not be flagged as a security event. Further, the user may specify that short use of the door to temporarily open and close the door are not be flagged as security events. Instead, for example, the user may specify that the sensor and/or the remote controller are to determine a security event related to the door is occurring only if the door is determined to be open for a certain number of measurements or a certain amount of time. In this manner, the security system allows for user customization of alert indications and handling.

[0136] Alternatively, if the sensor and/or the remote controller reach step **544**, the sensor and/or the remote controller may determine a security event has occurred, for example, if the sensor and or the remote controller have been configured to treat a measurement value that does not satisfy the first magnetic field strength threshold (e.g., is less than, or less than or equal to, a magnetic strength associated with the first magnetic strength threshold) and does satisfy the second

magnetic field strength threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the second magnetic field strength value) in such a manner. Under any scenario, the sensor and/or the remote controller may generate and send a message to the user device to indicate a determined state of the door and a reported value of the magnetic field measurement. In this manner, the user of the user device is aware of the state of the door and may adjust operation of any device to reflect whether such a circumstance would be treated as a security event or not. The user may be provided with an option for responding to the determined security event.

[0137] After step **544**, the method may proceed again to step **530**, to allow the sensor to continue to monitor, measure, and report the value of the magnetic field strength. The method may proceed to step **530** based on resolution of any security event determined in step **544** and/or based on resuming operation after determining no security event occurred in step **544**.

[0138] FIG. **6** shows an example magnetic field strength check-in reporting message **600**. The magnetic field strength check-in reporting message **600** may be a check-in message or a check-in reporting message. The check-in reporting message **600** may be generated by a sensor (e.g., the sensor **302** or the sensor **400**) and may be transmitted by the sensor to a controller (e.g., the remote controller **304**). The check-in reporting message **600** may represent a portion of an entire or complete message generated and transmitted by the sensor. For example, the check-in reporting message **600** may represent a portion of an overall message (or a portion of an overall payload) generated and transmitted by the sensor. The sensor may periodically generate the check-in reporting message **600** and transmit it to a controller.

[0139] As shown in FIG. **6**, the check-in reporting message **600** may comprise different portions or fields **602** through **614**. The check-in reporting message **600** may be a modified Zigbee message. Specifically, the check-in reporting message **600** may have an extended payload compared to a typical Zigbee message, which may comprise no payload and therefore none of the fields shown in FIG. **6**. Each of the fields **602-614** may be newly added components of a message that conforms to the Zigbee protocol.

[0140] The check-in reporting message **600** may be sent by the sensor to the remote controller at any time including, for example, on a periodic basis. For example, the check-in reporting message **600** may be generated and transmitted by the sensor every 27 minutes. The remote controller may use any data or information provided by the check-in reporting message **600** to adjust operation of the sensor and/or the remote controller. For example, the remote controller may use the check-in reporting message **600** to adjust one or more thresholds used for comparison to any magnetic field strength measurement made by the sensor.

[0141] A first field **602** of the check-in reporting message **600** may provide an indication of a battery voltage of the sensor. The first field **602** may comprise 16 bits and may indicate the battery voltage as an unsigned integer value. The battery voltage may be expressed in millivolts (mV).

[0142] A second field **604** of the check-in reporting message **600** may provide an indication of a magnetic field strength measured by the sensor. The second field **602** may comprise 16 bits and may indicate the magnetic field strength as an unsigned integer value. The magnetic field strength may be expressed in milliTeslas (mT).

[0143] A third field **606** of the check-in reporting message **600** may provide an indication of a temperature measured by the sensor. The third field **606** may comprise 16 bits and may indicate the temperature as an integer value. The temperature may be expressed in Celsius.

[0144] A fourth field **608** of the check-in reporting message **600** may provide a received signal strength indicator (RSSI) (or an indicator of a received signal strength) measured by the sensor. RSSI may be an indication of a strength of a signal received by the sensor from the remote controller. The RSSI field **608** may comprise 8 bits and may indicate the RSSI as an integer value. The RSSI may be expressed in Watts (W), milliwatts (mW), or decibel-milliwatts (dBm).

[0145] A fifth field **610** of the check-in reporting message **600** may provide a link quality indicator (LQI) (or an indicator of a link quality) measured by the sensor. The LQI may be an indication of a quality of a signal received by the sensor from the remote controller. The LQI may be expressed as a bit error rate (BER). The LQI field **610** may comprise 8 bits and may indicate the LQI as an unsigned integer value. The LQI may provide an indication of interference experienced by the sensor and may supplement information provided by the RSSI field **608**. For example, if the sensor is operating in a high interference environment, the sensor may receive a strong signal from the remote controller (indicative of a relatively high RSSI) but may have difficulty processing the contents of the signal due to the interference. As such, the LQI field **610** provides an indication of interference and the ability of the sensor to effectively use the signal it receives from the remote controller.

[0146] A sixth field **612** of the check-in reporting message **600** may provide a count of a number of retries for sending the check-in reporting message **600**. The sixth field **612** may comprise 32 bits and may indicate the number of retries as an unsigned integer value. On a first attempt to send the check-in reporting message **600**, a value of the retries field **612** may be set to zero (0). If the sensor fails to receive a message from the remote controller acknowledging receipt of the message after it is first attempted to be sent to and received by the remote controller, the sensor may attempt to re-send the check-in reporting message **600**. On a second attempt to send the check-in reporting message **600**, the value of the retries field **612** may be set to one (1), to reflect that the sensor is retrying a first time to re-send the check-in reporting message **600**. The value comprised in the reties field **612** may be incremented by one (1) each time the check-in reporting message **600** is re-sent by the sensor. The check-in reporting message **600** may be sent by the sensor any number of times until the sensor receives a message from the remote controller acknowledging receipt of the check-in reporting message **600**.

[0147] A seventh field **614** of the check-in reporting message **600** may provide a count of a number of times the sensor has rejoined a network to enable communication with the remote controller. The seventh field **614** may comprise 32 bits and may indicate the number of rejoins as an unsigned integer value. Occasionally, the sensor may lose connectivity with the remote controller, which may prevent messages from the remote controller reaching the sensor or messages from the sensor reaching the remote controller. The rejoins field **614** may provide an indication of a number of times the sensor has had to re-initiate communications with the remote controller and may indicate whether the

network (e.g., the network **308**) over which the sensor and remote controller communication is stable or unreliable. The rejoins field **614** may provide an absolute count of the number of times the sensor has had to rejoin the network to maintain communications with the remote controller.

[0148] The check-in reporting message **600** may comprise additional fields or fewer fields than those shown in FIG. **6**. For example, during installation or steady-state use of a sensor, the RSSI field **608** may indicate a relatively strong signal being received by the sensor while the LQI field **610** may indicate that the signal being received by the sensor is of relatively low quality (e.g., has a relatively high BER). Based on these indications provided in the check-in reporting message **600**, the remote controller may provide an indication to the user (e.g., via the user device **306**) that the reception quality of the sensor is poor. The remote controller may provide an indication that the user should inspect the sensor to determine if re-installation/re-positioning of the sensor may be needed. For example, if the LQI field **610** indicates that the BER satisfies (e.g., is greater than, or greater than or equal to) a predetermined threshold (e.g., BER threshold), the remote controller may provide one or more such indications to the user.

[0149] Any device such as, for example, the remote controller **304**, the user device **308**, and/or the security monitor server **140** may use any data provided in the magnetic field strength field **604** to determine any trends (e.g., increases or decreases) related to measurements of the magnetic field strength if, for example, the door to which the sensor is attached is closed. Any number of measurements may be analyzed to determine any trend. A trend may show a decrease in the measured strength of the magnetic field over time if the door is closed. A trend may show an increase in the measured strength of the magnetic field over time if the door is closed. Any trend may be recognized or determined based on comparison of any current set of measurement data to any prior set of measurement data. For example, measured magnetic field strength data provided in the magnetic field strength field **604** may indicate that the measured magnetic field strength when the door is closed is consistently relatively lower than when the sensor is first installed. Over time, measured magnetic field strength data provided in the magnetic field strength field **604** may indicate that the measured magnetic field strength when the door is closed is trending lower over time, and eventually stabilizing to a level that is lower than the consistently relatively high measurements previously made. Similarly, for example, measured magnetic field strength data provided in the magnetic field strength field **604** may indicate that the measured magnetic field strength when the door is closed is consistently relatively higher than when the sensor is first installed. Over time, measured magnetic field strength data provided in the magnetic field strength field **604** may indicate that the measured magnetic field strength when the door is closed is trending higher over time, and eventually stabilizing to a level that is higher than the consistently relatively high measurements previously made. Based on determinations of such trends and changes in measurement values over time, one or more thresholds for detecting if the door is open or closed may be adjusted (e.g., increased or decreased) as described herein. Further, early warning signs of potential installation issues may be identified prior to a sensor indicating that the door is open when the door is in fact closed, for example, based on relatively weak magnetic field measurements being made due to positioning or alignment issues of the sensor or corresponding magnet. Likewise, early warning signs of potential installation issues may be identified prior to a sensor indicating that the door is closed when the door is in fact open, for example, based on relatively strong magnetic field measurements being made due to positioning or alignment issues of the sensor or corresponding magnet.

[0150] FIG. **7** shows an example magnetic field zone event reporting message **700**. The magnetic field zone event reporting message **700** may be a zone event reporting message or an event reporting message. The event reporting message **700** may be generated by a sensor (e.g., the sensor **302** or the sensor **400**) and may be transmitted by the sensor to a controller (e.g., the remote controller **304**). The event reporting message **700** may represent a portion of an entire or complete message generated and transmitted by the sensor. For example, the event reporting message **700** may represent a portion of an overall message (or a portion of an overall payload) generated and transmitted by the sensor.

[0151] As shown in FIG. **7**, the event reporting message **700** may comprise different portions or fields **702** through **708**, along with the fields **602-614** contained in the check-in reporting message **600**. The event reporting message **700** may be a modified Zigbee message. Specifically, the event reporting message **700** may have an extended payload compared to a message that conforms to the Zigbee protocol. Each of the fields **602-614** may be newly added components of a typical Zigbee message (e.g., a zone event reporting message). As such, the fields **610-614** may represented a modified payload.

[0152] The event reporting message **700** may be sent by the sensor to the remote controller in response to a change in a magnetic field strength as measured by the sensor. For example, the event reporting message **700** may be generated and transmitted by the sensor whenever the magnetic field strength measured by the sensor changes by a threshold amount (e.g., by a threshold value, magnitude, or percentage change compared to a prior value). The event reporting message **700** may therefore be used to report a change in a status of an object to which the sensor is attached.

[0153] For example, if the sensor is attached to a door and the door is opened after being closed for a substantial period of time, the magnetic field strength measured by the sensor when the door is open will be significantly weaker than the magnetic field strength measured by the sensor when the door is closed. If the change in the measured magnetic field strength satisfies a predetermined threshold (e.g., meets or exceeds a predetermined threshold), the sensor may generate and transmit the event reporting message **700**. In doing so, the event reporting message **700** may be used to indicate if a door is opened and/or if a door is closed. The remote controller may use any data or information provided by the event reporting message **700** to indicate a security event. For example, based on receipt of the event reporting message **700**, the remote controller may provide a message to a user device (e.g., the user device **306**) and/or a remote server (e.g., the security monitor server **140**) indicating that a security event is occurring with respect to the door (e.g., the door has either been opened or closed). The predetermined threshold may be set to any value or percentage.

[0154] A first field **702** of the event reporting message **700** may provide an indication of a status of a zone associated with the sensor. For example, the sensor may be attached to

a door which may be a zone being monitored (e.g., the by monitoring system **300**). The zone status field **702** may indicate a current status of the zone-such as, for example, whether a security event is occurring with respect to the zone. For example, zone status field **702** may indicate whether the door has been opened or if the door has been closed. The zone status field **702** may comprise a bitmap of 16 bits.

[0155] A second field **704** of the event reporting message **700** may provide extended zone status information. By default, the extended zone status field **704** may be set to zero (0). The zone status field **702** may comprise a bitmap of 8 bits.

[0156] A third field **706** of the event reporting message **700** may indicate a zone identification (ID). The zone ID field **706** may provide further information for identifying the zone or particular door to which the sensor is attached. The zone ID field **706** may comprise 8 bits and may indicate the zone ID as an unsigned integer value.

[0157] A fourth field **706** of the event reporting message **700** may indicate a delay parameter. The delay parameter field **708** may provide an indication of an amount of time (e.g., in quarter-seconds) between the sensor detecting a change in the measured strength of the magnetic field that satisfies the predetermined threshold (e.g., is greater than, or greater than or equal to, a magnetic field strength associated with the predetermined threshold) to when the event reporting message **700** is transmitted. The delay parameter field **708** may allow the remote controller to assess congestion of the network (e.g., the network **308**) that is used for communications between the sensor and the remote controller.

[0158] The remaining fields **602** through **614** of the event reporting message **700** may be the same as or similar to the corresponding fields shown and described in relation to FIG. **6**. The event reporting message **700** may comprise additional fields or fewer fields than those shown in FIG. **7**.

[0159] FIG. **8** shows an example user interface **800**. The user interface **800** may be provided on any device described herein including, for example, a mobile user device (e.g., the user device **306**). The user interface **800** may be part of an application (app) provided on a mobile user device (e.g., a smartphone). The user interface **800** may provide information regarding a status of operation of a security monitoring system as described herein (e.g., the system **300**). The user interface **800** may provide information regarding a status of operation of any individual component of the security monitoring system (e.g., the sensor **302**, the sensor **400**, the remote controller **304**, and/or the security monitor server **140**). The user interface **800** may provide information regarding a determined security event (e.g., alert a user if a door is opened).

[0160] The user interface **800** may provide data or information using any graphical, visual, audible, and/or tactile indicators, or any combination thereof. The user interface **800** may enable a user to determine the status of a particular sensor. For example, the user interface **800** may provide information as to whether a particular sensor is on or off, the amount of battery life left, and/or whether the sensor has connectivity to a remote controller. The user interface **800** may enable a user to determine the status of the remote controller. For example, the user interface **800** may provide information as to whether the sensor is on or off, the amount of battery life left, whether the remote controller has connectivity to a particular sensor, whether the remote controller has connectivity to the remote server, and/or whether the remote controller has connectivity to the user device.

[0161] The user interface **800** may provide data that is collected or determined by any sensor. For example, the user interface **800** may provide information regarding signal strength measurements and/or magnetic field strength measurements made by a particular sensor. Further, with regard to a particular sensor, the user interface **800** may provide information regarding any current measurement made by the sensor, any history of measurements made by the sensor, and any trends related to measurements made by the sensor (e.g., whether magnetic field strength measurements made when the door are closed are stable or trending lower over time).

[0162] The user interface **800** may provide data regarding any object being monitored by the security system (e.g., a door or a window). For example, the user interface **800** may provide information regarding whether a door is open or closed, a history of use of the door, when the door was last opened, and/or how long the door was last opened. The user interface **800** may provide alerts or notifications as to whether a door is currently open, partially open, or closed. The user interface **800** may also provide information to identify each monitored object uniquely (e.g., a unique door ID or name) and may provide a history of all magnetic field strength measurements related to the monitored object.

[0163] The user interface **800** may provide alerts or indications as to any change in operation of any component (e.g., any sensor) of the security system. For example, the user interface **800** may provide an indication that a magnetic field strength as measured by a particular sensor if a door to which the sensor is attached is lower than a magnetic field strength measured by the sensor earlier in time (e.g., during installation or shortly thereafter). The user interface **800** may provide an indication of any trend in the change in the magnetic field strength measurements made by the sensor and may indicate if current measurements are a threshold amount below an initial or benchmark measurement of the magnetic field strength when the door is closed. The user interface **800** may provide a recommend change to any magnetic field strength measurement thresholds to the user. The user interface **800** may allow the user to manage any changes to any magnetic field strength measurement thresholds including, for example, permitting the user interface **800** to make automatic adjustments or requesting any recommended change be approved by the user. If changes to measurements drop significantly (e.g., are less than the initial or benchmark measurement by a further threshold), the user interface **800** may alert the user that a more significant issue regarding the installation or positioning of the sensor may be occurring and may suggest that a visual inspection of the sensor should be made.

[0164] The user interface **800** may allow a user to set or adjust any preferences or preferred operations of the security system. For example, for a particular object being monitored (e.g., a door), the user interface **800** may allow a user to set a preference for whether to be alerted about the battery life remaining in an associated sensor. The user interface **800** may allow a user to specify whether to be alerted about a security event—for example, whether and how to be alerted if a door is opened, if a door is closed, and/or if a door is partially opened. The user interface **800** may allow a user to specify that no alert is to be provided for a door that is partially opened unless the door remains partially opened for more than a threshold amount of time.

[0165] Other data and information may be provided by the user interface **800** including any other data or information collected or generated by any component of the security system. For example, the user interface **800** may provide temperature information, motion detection information, smoke detection information, and/or moisture detection information for different areas of a premises (e.g., the premises **102***a*) based on data collected and/or processed by any sensor.

[0166] As shown in FIG. **8**, the user interface **800** is providing an alert to a user related to a particular object being monitored by a particular sensor of the security monitoring system. The alert may comprise textual information **802** to convey an urgency associated with the alert. The user interface **800** may provide a description **804** of the alert. The description **804** may be provided in a narrative style. The description **804** may comprise a description or ID of the object **806** (e.g., the "side door"), a description or ID of the premises **808** (e.g., "your house"—to distinguish multiple premises that may be monitored), and/or an indication of a security event related to the object **810** (e.g., that the side door is "open").

[0167] As further shown in FIG. **8**, the user interface **800** may provide options for a user to respond to the alert **802**. For example, the user interface **800** may provide the user with a first option **812** to clear the indicated alert and/or may provide the user with a second option **814** to alert the authorities regarding the security event. A user may choose the second option **814**, for example, if the user determines the security event is serious and the user is not at the premises where the security event is taking place. If a user engages the second option **814**, an automatic phone call or other notification may be provided to a local police or fire department. If a user engages the first option **812**, the alert **802** may be removed from the user interface **800**.

[0168] The user interface **800** may provide the user with a third option **816** to adjust or modify any operation settings relating to the security system or a particular system. If a user engages the third option **816**, for example, one or more menus may be presented to the user for adjusting any operation of a particular sensor. The user interface **800** may provide the user with a fourth option **818** to view any measurement history data or notification history data related to a particular monitored object or associated sensor. If a user engages the fourth option **818**, for example, one or more menus may be presented to the user to view a history of any data collected by a particular sensor (e.g., a history of magnetic field strength measurements, a history of received signal power strength measurements, a history of temperature measurements, etc.) and/or a history of any notifications associated with an object or sensor (e.g., when the last notification regarding a particular door was made, how the notification was resolved, etc.).

[0169] Although examples are provided in the context of a sensor attached to a door or window and a magnet attached to a corresponding door frame or window frame, respectively, the apparatuses, systems, and methods described herein are not so limited. The apparatuses, systems, and methods described herein may be used with any type of structure that includes a first element (or object) that is moveable relative to a second element (or object). The apparatuses, systems, and methods described herein may be used to detect a movement of the first element based on positioning the sensor on the first element and positioning the magnet on the second object. Alternatively, the apparatuses, systems, and methods described herein may be used to detect a movement of the first element based on positioning the magnet on the first element and positioning the sensor on the second object. The first element may be any physical element such as, for example, a hatch, a cabinet door, a first portion of a French door or double door, or a drawer and the second element may be any corresponding physical element such as, for example, a bulkhead, a cabinet frame, a wall, a second portion of a French door or double door, or a dresser or office cabinet. The apparatuses, systems, and methods described herein may use various predetermined thresholds, levels, or values as described herein. Any predetermined threshold, level, or value may be prestored or hard coded into any of the devices described herein or may be set by a user.

[0170] Although examples are described above, features and/or steps of those examples may be combined, divided, omitted, rearranged, revised, and/or augmented in any desired manner. Various alterations, modifications, and improvements will readily occur to those skilled in the art. Such alterations, modifications, and improvements are intended to be part of this description, though not expressly stated herein, and are intended to be within the spirit and scope of the disclosure. Accordingly, the foregoing description is by way of example only, and is not limiting.

1. A method comprising:

determining, by a computing device and based on a plurality of first sensor messages, indicating a corresponding plurality of measured strengths of a magnetic field, a reduction in a strength of the magnetic field;

sending, from the computing device to a user device, a second message comprising a request to modify a first threshold for detecting an alarm condition; and

causing, by the computing device and based on an instruction from the user device, setting of a modified threshold, lower than an original threshold, for detecting the alarm condition.

2. The method of claim **1**, wherein the second message further comprises a proposed modified threshold value.

3. The method of claim **1**, wherein determining the reduction in the strength of the magnetic field further comprises determining that each measured strength of the plurality of measured strengths of the magnetic field is within a predetermined range of the original threshold.

4. The method of claim **1**, wherein determining the reduction in the strength of the magnetic field further comprises determining that each measured strength of the plurality of measured strengths of the magnetic field is lower than a first measured strength of the magnetic field by at least a predetermined amount.

5. The method of claim **1**, further comprising causing setting of the original threshold to be a predetermined amount less than a first measured strength of the magnetic field.

6. The method of claim **1**, wherein causing setting of the modified threshold further comprises causing setting of the modified threshold to be a predetermined amount less than a lowest measured strength of the corresponding plurality of measured strengths of the magnetic field.

7. The method of claim **1**, wherein causing setting of the modified threshold further comprises causing setting of the modified threshold to be a predetermined amount less than

an average measured strength of the corresponding plurality of measured strengths of the magnetic field.

8. The method of claim **1**, wherein the instruction from the user device comprises approval of a proposed modified threshold value.

9. The method of claim **1**, wherein the second message further comprises an indication of the reduction in the strength of the magnetic field.

10. The method of claim **1**, wherein the second message further comprises an indication of a potential problem with a sensor associated with the plurality of first sensor messages.

11. The method of claim **1**, wherein causing setting of the modified threshold further comprises causing setting of the modified threshold based on a user input.

12. The method of claim **1**, further comprising:

receiving, by the computing device from a sensor associated with the plurality of first sensor messages, a third message indicating an additional measured strength of the magnetic field;

comparing, by the computing device, the additional measured strength of the magnetic field to the modified threshold; and

sending, from the computing device to the user device based on the additional measured strength of the magnetic field not satisfying the modified threshold, a fourth message indicating the alarm condition.

13. The method of claim **1**, further comprising:

receiving, by the computing device from a sensor associated with the plurality of first sensor messages, and prior to causing setting of the modified threshold, a third message indicating an additional measured strength of the magnetic field;

determining, by the computing device, that the additional measured strength of the magnetic field does not satisfy the original threshold; and

sending, from the computing device to the user device based on determining the reduction in the strength of the magnetic field, a fourth message indicating a false alarm condition.

14. The method of claim **1**, wherein the second message further comprises an indication that a change in a position of a sensor associated with the plurality of first sensor messages may have occurred.

15. An apparatus comprising:

one or more processors; and

memory storing instructions that, when executed by the one or more processors, cause the apparatus to:

determine, based on a plurality of first sensor messages, indicating a corresponding plurality of measured strengths of a magnetic field, a reduction in a strength of the magnetic field;

send, to a user device, a second message comprising a request to modify a first threshold for detecting an alarm condition; and

cause, based on an instruction from the user device, setting of a modified threshold, lower than an original threshold, for detecting the alarm condition.

16. The apparatus of claim **15**, wherein the second message further comprises a proposed modified threshold value.

17. The apparatus of claim **15**, wherein the instructions, when executed by the one or more processors further cause the apparatus to cause setting of the modified threshold to be a predetermined amount less than an average measured strength of the corresponding plurality of measured strengths of the magnetic field.

18. The apparatus of claim **15**, wherein the instruction from the user device comprises approval of a proposed modified threshold value.

19. The apparatus of claim **15**, wherein the second message further comprises an indication of the reduction in the strength of the magnetic field.

20. The apparatus of claim **15**, wherein the second message further comprises an indication of a potential problem with a sensor associated with the plurality of first sensor messages.

21. The apparatus of claim **15**, wherein the instructions, when executed by the one or more processors further cause the apparatus to cause setting of the modified threshold based on a user input.

22. The apparatus of claim **15**, wherein the second message further comprises an indication that a change in a position of a sensor associated with the plurality of first sensor messages may have occurred.

23. A non-transitory computer-readable medium storing instructions that, when executed, cause:

determining, by a computing device and based on a plurality of first sensor messages, indicating a corresponding plurality of measured strengths of a magnetic field, a reduction in a strength of the magnetic field;

sending, from the computing device to a user device, a second message comprising a request to modify a first threshold for detecting an alarm condition; and

causing, by the computing device and based on an instruction from the user device, setting of a modified threshold, lower than an original threshold, for detecting the alarm condition.

24. The non-transitory computer-readable medium of claim **23**, wherein the second message further comprises a proposed modified threshold value.

25. The non-transitory computer-readable medium of claim **23**, wherein the instructions, when executed, further cause setting of the modified threshold to be a predetermined amount less than an average measured strength of the corresponding plurality of measured strengths of the magnetic field.

26. The non-transitory computer-readable medium of claim **23**, wherein the instruction from the user device comprises approval of a proposed modified threshold value.

27. The non-transitory computer-readable medium of claim **23**, wherein the second message further comprises an indication of the reduction in the strength of the magnetic field.

28. The non-transitory computer-readable medium of claim **23**, wherein the second message further comprises an indication of a potential problem with a sensor associated with the plurality of first sensor messages.

29. The non-transitory computer-readable medium of claim **23**, wherein the instructions, when executed, further cause setting of the modified threshold based on a user input.

30. The non-transitory computer-readable medium of claim **23**, wherein the second message further comprises an indication that a change in a position of a sensor associated with the plurality of first sensor messages may have occurred.

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