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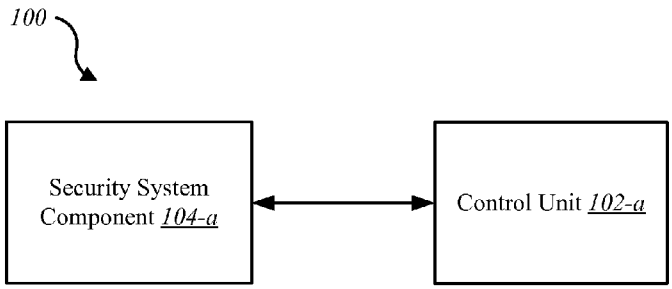

FIG. 1

(57) Abstract: Methods and systems are described for detecting a premise condition. According to at least one embodiment, a method for detecting a premise condition includes detecting a sound with a security system component, determining with the security system component whether the sound belongs to a recognized class of sounds, sending the recognized class to a remote control unit, and causing with the remote control unit a predetermined response to occur based on the recognized class. In one embodiment, the method includes using a microphone to monitor for sounds at a building, detecting a sound via the microphone, and determining whether the sound is made by a human or made by an animal. In some cases, the microphone is a glass break sensor microphone.

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DETECTING A PREMISE CONDITION USING AUDIO ANALYTICS

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Application No. 14/304,644, entitled DETECTING A PREMISE CONDITION USING AUDIO ANALYTICS, filed on June 13, 2014; and U.S. Application No. 14/316,597, entitled VERIFYING OCCUPANCY OF A BUILDING, filed on June 26, 2014, both of which are incorporated herein in their entirety by this reference.

BACKGROUND

[0002] Homeowners are often concerned about the security of their homes and accordingly install security cameras to monitor the premise of their homes. Such video cameras capture footage of the events within their field of view when the video cameras are turned on. The footage of the video camera is often stored locally on the camera or sometimes the video footage is sent to a remote location where the footage is accessible to the homeowners.

DISCLOSURE OF THE INVENTION

[0003] Methods and systems are described for detecting a premise condition. According to at least one embodiment, a method for detecting a premise condition includes detecting a sound with a security system component, determining with a security system component whether the sound belongs to a recognized class of sounds, sending the recognized class to a remote control unit, and causing with the remote control unit a predetermined response to occur based on the recognized class. In some embodiments, the security system component is a video camera. However, in other examples, the security system component is a motion detector or another type of security system component.

[0004] Any appropriate type of recognized class may be used in accordance with the principles described in the present disclosure. For example, at least one of the recognized classes may include a security class, a health condition class, a property damage class, an alarm class, another type of recognized class, or combinations thereof. The sounds that belong to at least one of the recognized classes may include the sounds of a crying baby above a predetermined threshold,

barking dogs sounds, breaking glass sounds, talking sounds, fire alarms sounds, carbon monoxide alarms sounds, other types of alarms sounds, other types of sounds, or combinations thereof.

[0005] Any appropriate type of predetermined response may be implemented in response to determining that a sound is from one of the recognized classes. For example, a non-exhaustive list of predetermined responses may include causing a security camera to exit a sleep mode, sending a message to law enforcement, sending a message to medical personnel, displaying a message on a security panel, activating an alarm, sending a notification to a mobile device, locking a door, unlocking a door, performing another predetermined response, or combinations thereof.

[0006] In another aspect of the principles described herein, a video camera is configured for detecting a premise condition. The video camera includes a processor, memory in electronic communication with the processor, and instructions stored in the memory. The instructions are executable by the processor to detect a sound with a microphone in the video camera, determine with the video camera whether the sound belongs to a recognized class of sounds, and send the recognized class to a remote control unit.

[0007] In yet another aspect of the principles described herein, a computer program product is used for detecting a premise condition. The computer-program product includes a non-transitory computer-readable medium having instructions thereon. The instructions are executable by a processor to detect a sound with a security system component, determine with the security system component whether the sound belongs to a recognized class of sounds, send the recognized class to a remote control unit, and cause with the remote control unit a predetermined response to occur based on the recognized class.

[0008] According to at least one embodiment, a method for detecting occupancy of a building is also described. In one embodiment, the method may include using a microphone to monitor for sounds at a building, detecting a sound via the microphone, and determining whether the sound is made by a human or made by a pet. In some cases, the microphone may be a glass break sensor microphone.

[0009] In some embodiments, the method may include identifying a human footstep from the sound, identifying a human voice from the sound, identifying an animal footstep from the sound, and/or identifying an animal sound from the sound. In some cases, the method may include detecting a triggering of a motion sensor and analyzing the sound in relation to the triggering of the motion sensor. Upon detecting the triggering of the motion sensor and determining the sound is made by a pet, the method may include ignoring the triggering of the motion sensor. Upon detecting the triggering of the motion sensor and determining the sound is made by a human, the method may include triggering an alarm. In some embodiments, the method include determining whether the sound originates within the building or outside the building.

[0010] A computing device configured for detecting occupancy of a building is also described. The computing device may include a processor and memory in electronic communication with the processor. The memory may store computer executable instructions that when executed by the processor cause the processor to perform the steps of using a microphone to monitor for sounds at a building, detecting a sound via the microphone, and determining whether the sound is made by a human or made by a pet. In some cases, the microphone may be a glass break sensor microphone.

A non-transitory computer-readable storage medium storing computer executable instructions is also described. When the instructions are executed by a processor, the execution of the instructions may cause the processor to perform the steps of using a microphone to monitor for sounds at a building, detecting a sound via the microphone, and determining whether the sound is made by a human or made by a pet. In some cases, the microphone may be a glass break sensor microphone.

[0011] The foregoing has outlined rather broadly the features and technical advantages of examples according to the disclosure in order that the detailed description that follows may be better understood. Additional features and advantages will be described hereinafter. The conception and specific examples disclosed may be readily utilized as a basis for modifying or designing other structures for carrying out the same purposes of the present disclosure. Such equivalent constructions do not depart from the spirit and scope of the appended

claims. Features which are believed to be characteristic of the concepts disclosed herein, both as to their organization and method of operation, together with associated advantages will be better understood from the following description when considered in connection with the accompanying figures. Each of the figures is provided for the purpose of illustration and description only, and not as a definition of the limits of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] A further understanding of the nature and advantages of the embodiments may be realized by reference to the following drawings. In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

[0013] FIG. 1 is a block diagram of an example of an environment in which the present systems and methods may be implemented;

[0014] FIG. 2 is a block diagram of an example of a control unit of the environment shown in FIG. 1;

[0015] FIG. 3 is a block diagram of an example of a response module of the control unit of FIG. 2;

[0016] FIG. 4 is a block diagram of an example of a security system component of the environment of FIG. 1;

[0017] FIG. 5 is a block diagram of an example of a recognized class module of the security system component of FIG. 4;

[0018] FIG. 6 is a block diagram illustrating one embodiment of an environment in which the present systems and methods may be implemented;

[0019] FIG. 7 is a block diagram illustrating one example of an occupancy detection module;

[0020] FIG. 8 is a block diagram illustrating one example of an environment for detecting occupancy of a building to improve awareness regarding detected events;

[0021] FIG. 9 is a flow diagram illustrating an example of a method for detecting a premise condition;

[0022] FIG. 10 is a flow diagram illustrating an example of a method for detecting a premise condition;

[0023] FIG. 11 is a flow diagram illustrating an example of a method for detecting a premise condition;

[0024] FIG. 12 is a flow diagram illustrating one embodiment of a method for detecting occupancy of a building;

[0025] FIG. 13 is a flow diagram illustrating one embodiment of a method for detecting occupancy of a building;

[0026] FIG. 14 is a block diagram of a computer system suitable for implementing the present systems and methods; and

[0027] FIG. 15 depicts a block diagram of another computer system suitable for implementing the present systems and methods.

[0028] While the embodiments described herein are susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. However, the exemplary embodiments described herein are not intended to be limited to the particular forms disclosed. Rather, the instant disclosure covers all modifications, equivalents, and alternatives falling within the scope of the appended claims.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0029] The systems and methods described herein relate to home automation and home security, and related security systems and automation for use in commercial and business settings. More specifically, the system and methods relate to detecting a premise condition using audio analytics. Sounds occurring on or near the premise can be detected and analyzed. In response to the analysis, the system and methods can be implemented to perform tasks that are responsive to the detected sounds. In other words, a predetermined action may be initiated in response

to determining that the sound is of a certain type. As an example, if the sound of breaking glass is a predetermined classification of sounds of interest, the sound of breaking glass may trigger a camera to turn on, while the sound of the neighbor's lawn mower will not trigger the camera to turn on.

[0030] As used herein, the term "module" includes a combination of hardware and programmed instructions that are necessary for performing the designated function of the module. Components of the modules may be located on the same physical device or some of the components may be located at remote locations that are in communication with the other components of the module.

[0031] **FIG. 1** is a block diagram depicting one embodiment of an environment 100 in which the present systems and methods may be implemented. In some embodiments, the environment 100 includes a control unit 102-a that is in communication with a security system component 104-a. The control unit 102-a may also be in communication with components of other systems, such as lighting systems, climate control systems, home automation systems, other types of systems, or combinations thereof. The control unit 102-a may be in direct communication with the security system component 104-a or in indirect communication with the security system component 104-a through an intermediate device, such as a cloud based device. a mobile device, another type of device, or combinations thereof.

[0032] Any appropriate mechanism for communicating between the control unit 102-a and the security system component 104-a may be used. In some examples, a wireless network is utilized to communicate between the control unit 102-a and the security system component 104-a. Examples of networks that may be used include, but are not limited to, local area networks (LAN), wide area networks (WAN), virtual private networks (VPN), wireless networks (using 802.11, for example), and/or cellular networks (using 3G and/or LTE, for example), Bluetooth networks, z-wave networks, ZigBee networks, other types of networks, or combinations thereof.

[0033] The control unit 102-a may control at least a part of the security and/or automation system. For example, other sensors (not shown) and/or actuators (not shown) may send information to the control unit 102-a where the signals are processed. The such sensors may include, for example, a camera sensor, audio

sensor, forced entry sensor, shock sensor, proximity sensor, boundary sensor, appliance sensor, light fixture sensor, temperature sensor, light beam sensor, three-dimensional (3-D) sensor, motion sensor, smoke sensor, glass break sensor, door sensor, window sensor, carbon monoxide sensor, accelerometer, global positioning system (GPS) sensor, Wi-Fi positioning system sensor, capacitance sensor, radio frequency sensor, near-field sensor, heartbeat sensor, breathing sensor, oxygen sensor, carbon dioxide sensor, brain wave sensor, movement sensor, voice sensor, other types of sensors, or combinations thereof. Such actuators may include, for example, automated door locks, climate control adjustors, lighting adjusters, sensors activation mechanisms, other types of actuators, or combinations thereof.

[0034] The control unit 102-a may make decisions based on the communications from these sensors. For example, based on the information sent from these sensors to the control unit 102-a, the control unit 102-a may make a decision to activate an alarm, adjust a climate control setting, open or close a window, lock or unlock a door, control a security parameter, manage energy consumption, check the status of a door, locate a person or item, control lighting, control cameras, receive notifications regarding a current status or anomaly associated with a building, perform another task, or combinations thereof. In some cases, a decision may be decided at one of the local sensors, and the local sensors may or may not notify the control unit 102-a of the decision and/or resulting action.

[0035] In some examples, the control unit 102-a includes a user interface where the user can interact with the control unit 102-a. For example, the user can manually give instructions to the control unit 102-a to adjust a building parameter or perform another system task.

[0036] The security system component 104-a may be any appropriate type of security device. For example, the security system component 104-a may include a video camera, a microphone, a motion detector, a sensor, another type of security device, or combinations thereof. In response to detecting a sound, the security system component 104-a may classify the sound and send the classification to the control unit 102-a. Based on the received classification, the control unit 102-a may cause a predetermined response to occur. For example, a security type of classification may result in a message being sent to law enforcement and/or turning

on a security camera, a health condition type of classification may result in a message being sent to medical personnel, an alarm type classification may result in a message being sent to the user's mobile phone, or combinations thereof.

[0037] The security system component 104-a may include an ability to detect sounds from the ambient environment. Such a capability may include the ability to determine attributes about the detected sounds. For example, the security system component 104-a can determine the waveform generated by the sound, the pitch of the sound, the amplitude of the sound, decibel level of the sound, the reflection characteristics of the sound, the period of the sound's wavelength cycle, the acoustic pressure of the sound, the intensity of the sound, the speed of the sound, the direction of the sound, other attributes of the sound, or combinations thereof.

[0038] In some examples, the security system component 104-b is located within a building, such as a home. In other examples, the security system component 104-b is located outside of the home. In some situations, multiple security system components are used collectively to detect and analyze sounds.

[0039] The attributes of the sound can be used to determine the sound's source and to recognize the type of sound. For example, the sound of an automobile driving by the home may be detected by the security system component 104-a. The security system component 104-a may analyze the detected sound's attributes, such as frequency and amplitude. Such attributes may be compared to sound signatures stored in a sound library within the security system component 104-a to determine if there is a correlation between the sound attributes and one of the stored sound signatures. If there appears to be a strong enough correlation, the security system component 104-a may conclude that the sound belongs to a particular recognized class of sounds.

[0040] In some cases, the recognized class of sounds covers a broad scope, such as automobile sounds. In other examples, the recognized class of sounds includes a narrower scope that gives more detail about the sound. For example, questions such as whether the car is idling in the driveway, whether the automobile is close or far from the home, and other types of questions may be not determined in a class scope with a broad scope. Thus, for appropriate types of sounds, the recognized classes may have narrower scopes to obtain more useful information. In

such an example, the length of time that the automobile's sound is detected may be used to help determine whether the sound belongs to a passing by automobile classification or to an idling parked automobile classification. Other attributes may also help determine the distance of the car from the home. For example, the sound's strength may be used to determine whether the sound belongs in a class that recognizes that the sound is close or far from the home.

[0041] Further, an analysis of the sound's attributes may also help determine the location of the sound's source. For example, the source of the automobile's sound may be from the street adjacent the home, a street farther away from the home, in the driveway, or at another location. As the sound travels, the integrity of the sound wave may diminish. Further, as the sound travels from the automobile to the security system component 104-a, the sound wave may further degrade from interaction with acoustic impedance boundaries, such as walls, other cars, pedestrians, mailboxes, and other boundaries. In one such situation, a portion of the sound's energy will be reflected in a different direction when the sound contacts the wall of the home. The security system component 104-a may be able to detect such reflections through a reduction in the sound's strength or other resulting characteristics of the detected sound. Thus, the security system component 104-a may be able to determine if the sound is coming from a source on a different side of the home's wall than the security system component 104-a. In other examples, the security system component 104-a may determine that the sound's source is on the same side of the wall as the security system component 104-a when the sound is accompanied by weaker reflected waveforms arriving at the security system component 104-a at slightly different times.

[0042] Using narrower recognized classes may be appropriate in those situations where the distinctions between the recognized classes are associated with different types of predetermined responses. For example, a predetermined response to a car idling in the driveway may be to turn on a video camera. On the other hand, a car driving by on the street next to the home without stopping may not trigger a response. Thus, a narrow recognized class for idling parked automobiles may trigger a response while a narrow recognized class for automobiles driving by may not trigger a response at all. In some instances, the recognized classes may be narrow

enough so that different desired responses do not overlap between recognized classes.

[0043] An example of situation where a broad classification is appropriate includes the sound of breaking glass. In such a situation, the homeowner may desire a notification of breaking glass regardless of whether the glass is part of a window, dinnerware, door, cabinet, car window, or other structure. Thus, any sound that is classified as breaking glass may trigger the same type of predetermined response.

[0044] In some examples, just those sounds that are associated with a predetermined response will be associated to a recognized class. In other examples, some of the recognized classes correspond with sounds that do not trigger predetermined responses. For example, the security system component 104-a may include signatures to sound sources that should not trigger a predetermined response, but may be confused with similar types of sounds that come from sources that should trigger a predetermined response.

[0045] In some situations, a homeowner may have the option of assigning the predetermined responses to the different types of sounds stored in the security system component 104-a. For example, the homeowner may have the option of notifying law enforcement personnel automatically if the sound of breaking glass is detected. However, the homeowner may also have the option to merely turn on the video camera, send a notification to the homeowner's mobile device, send a video stream to the homeowner's mobile device, take no action, other options, or combinations thereof.

[0046] In another example, the detected sound may be a voice of a specific individual. In some cases such voice recognition may be used to determine whether a household resident is home. In response to determining that the resident is home, the predetermined response may include executing specific user preferences. For example, if the user has a preference of an open window during days with certain whether conditions, the system may cause a window to open if the weather conditions are met. In other examples, the detected sound may be the voice of an unwelcomed person in the home. Such an examples may include an estranged spouse, an individual with a restraining order, or another type of unwelcome person. In response to recognizing the sound from such an unwelcome person, law

enforcement may be notified, parents may receive notifications, or other types of predetermined responses may be executed.

[0047] **FIG. 2** is a block diagram illustrating one example of a control unit 102-b. In this example, the control unit 102-b has a class recognition module 200-a and a response module 202-a.

[0048] The class recognition module 200-a may receive the identification of the recognized class from the security system component 104-a. In response to receiving the identification of the recognized class, the security system component 104-a may consult with a table that associates the types of predetermined responses with the recognized classes. Based on the associations, the control unit 102-b may send a message to the response module 202-a with instructions to execute a predetermined response.

[0049] The response module 202-a may include programmed code to cause the predetermined responses to be carried out. In some examples, the class recognition module 200-a does not send instructions to the response module 202-a if the table indicates that there is no assigned predetermined response associated with the received recognized class. In other examples, the class recognition module 200-a notifies the response module 202-a that there is no predetermined response to execute. Each recognized class may be associated with no predetermined response, a single predetermined response, or multiple predetermined responses. For example, a security related class may be associated with predetermined responses for turning on video cameras, notifying law enforcement personnel, sending a notification to the user's mobile device, and other types of predetermined responses.

[0050] **FIG. 3** is a block diagram illustrating one example of a response module 202-b. In this example, the response module 202-b has a camera module 300, a law enforcement module 302, a health condition module 304, a mobile device module 306, an alarm module 308, and a display module 310.

[0051] The camera module 300 includes programmed instructions for controlling a video camera. In one example, the video camera may have a sleep mode that conserves energy if the premise of the home appears to be without activities of interest. However, certain sounds may be associated with activities of interest. Thus, in response to receiving the appropriate classifications, the camera

module 300 may cause at least one video camera to turn on. The camera module 300 may also control other functions of the video camera. In some examples, the video camera may always be turned on, and the camera module 300 triggers a different function in response to receiving the recognized class. One such function may include what is covered in the camera's field of view. For example, if the recognized class is classified as a breaking kitchen door sound, the camera module 300 may response by turning the camera so that the camera's field of view captures footage of activities happening around the kitchen door. In other examples, the camera module 300 may zoom in or out as part of a predetermined response.

[0052] While the camera module 300 may include specific predetermined responses associated with the receipt of a recognized class, the camera module 300 may also include the ability to make dynamic decisions depending on the situation. For example, if the predetermined response is to turn on the camera, the camera module may make additional decisions beyond the predetermined response as appropriate. Such additional decisions may include zooming, panning, trucking, tilting, or otherwise controlling the camera's field of view if the camera's or the control unit's logic determines that the field of view could be positioned differently to get more useful information. In other examples, the video camera may detect the presence of a hazard, such as a fire, flooding, an intruder, other hazards, or combinations thereof. In response to such detections, the camera module 300 may cause additional types of appropriate predetermined responses to occur.

[0053] The law enforcement module 302 can send messages to law enforcement. Such a predetermined response may be appropriate for situations where the recognized class of sounds includes a security issue, such as the detection of an intruder, a fight, another type of situation, or combinations thereof. The law enforcement module 302 may be activated in combination with other modules so that multiple appropriate predetermined responses are executed. In some examples, the law enforcement module 302 is activated in response to user input. In such an example, the predetermined response may include sending an option to the user to have law enforcement notified. In such a situation, the user may be informed about the recognized sound classification, provided with a recording of the sound, provided with other types of information, or combinations thereof.

[0054] The health condition module 304 can send messages to medical personnel. For example, if the sound belongs a recognized class that is associated with an injury, the health condition module 304 may be notified to summon the medical assistance. Sounds that may be assigned to such a recognized class include choking sounds, falling sounds, yelling sounds, explosion sounds, gunshot sounds, other types of sounds, or combinations thereof. In some cases, where the sounds indicate that there is a potential danger to the medical personnel, like explosion or gunshot sounds, the medical personnel may still be notified and allow the medical personnel to be aware that their services may be requested. The medical personnel can coordinate their rescue efforts with the appropriate rescue agency.

[0055] The user may specify which types of sounds should trigger a predetermined response to the health condition module 304. If an elderly person lives in a home, the types of sounds that may indicate a potential health concern may be different for those homes where the younger children live. For example, falling sounds from an elderly person's home may have a greater potential to indicate that there is a health condition than in a younger person's home. In such a situation, the homeowner can specify that such sounds are to be associated with notifying medical personnel responses. In another example, some residents in a home may also have specific health conditions that are associated with certain types of sounds that the homeowner can select to trigger medical personnel.

[0056] The mobile device module 306 may be used to send messages or other types of information to the user's mobile device. For example, the user may receive a notification about any of the sounds that are deemed appropriate to share with the user. Further, the mobile device module 306 may also give the user options for how to respond to any appropriate type of notification. For example, if the detected sound indicates that the washing machine or dishwasher is broken, the user may receive a notification through his or her mobile device about the broken appliance. In some situations, the notification may also include an option that can be selected by the user about whether to notify an appropriate repair person to fix the appliance. In other examples, the mobile device module 306 sends a notification to the user that a fire alarm, a carbon monoxide alarm, a security alarm, a weather alarm, or another type of alarm is sounding in the home. In such situations, the

notification to the mobile device is generated through hearing the alarm's sound with the security system component 104, and not through a notification mechanism directly integrated with the system sounding the alarm.

[0057] The alarm module 308 can trigger an alarm to be sounded in response to the detection of a sound that indicates specific types of conditions present on the premise. For example, a security alarm may be triggered in response sounds indicating that glass is breaking, an intruder is present, other types of conditions, or combinations thereof.

[0058] The display module 310 can cause messages to appear on the control unit 102. In such an example, any of the messages that can be sent to the mobile device can be presented in a display on the control unit 102. In some examples, the display on the control unit 102 may include additional options or details about the condition. In some cases, such a message may include an option for the user to select. Such an option may involve proper user authentication. For example, if the message deals with the detection of an intruder, the user authentication prevents the intruder from selecting a response to his presence. In other situations, the message may deal with a detected health condition and the user may be given the option to call medical personnel through the control unit 102.

[0059] **FIG. 4** is a block diagram illustrating one example of a security system component 104-b. In this example, the security system component 104-b includes a detection module 400, a recognized class module 402, and a communications module 404.

[0060] The detection module 400 detects the sound. Such a module may incorporate a microphone or another type of device that is capable to detecting sounds. The detection module 400 may also include the ability to capture the attributes of the sound, such as waveform characteristics, decibel levels, sound durations, other types of sound attributes, or combinations thereof. Further, the detection module 400 may break out such sound attributes into categories that are easy for analysis. In other examples, the detection module 400 plots the waveform in a chart for comparison with stored signatures associated with different recognized classes. In some cases, the detection module 400 operates just when the security

system is armed. However, in other cases, the detection module 400 can also operate when the security system is disarmed.

[0061] The recognized class module 402-a determines which class to associate with the detected sound. This may be through an analysis of the sound's attributes provided by the detection module 400. In some examples, the waveform plot of the sound is compared to the stored signatures in a class library of the security system component 104-b.

[0062] The communications module 404 communicates with the control unit 102. Such communications may be wireless communications or wired communications. The communications module 404 may send the identified recognized class to the control unit 102, where the control unit 102 can make a decision about how to respond to the recognized class. Thus, the analysis for determining the sound's recognized class is performed at the security system component 104-b and the decision for how to respond to the recognized class is performed at the control unit 102.

[0063] In some cases, sounds detected by the detection module 400 will not have enough similarity to the stored signatures. In such an example, the recognized class module 402-a may indicate that such a sound is unclassified. In some examples, the unclassified sounds are not sent to the control unit 102. As a result, no predetermined action is triggered when such a sound is detected.

[0064] By not responding to unclassified sounds, the system reacts to just those sounds that are predetermined to have a response. Thus, if the sound of car passing by a home does not fall within a recognized class, the security system will not initiate a predetermined response. Likewise, other sounds that are not predetermined to have a response, will not result in a predetermined response based on the classification of the sound type. In another example, if a baby crying sound above a specified decibel threshold falls into a recognized class associated with a predetermined response, and a baby cries at a decibel level below the specified threshold, there may be no response taken by the security system.

[0065] **FIG. 5** is a block diagram illustrating one example of a recognized class module 402-b. In this example, the recognized class module 402-b includes a class library 500, which includes a security class 502, a health condition class 504,

property damage class 506, and an alarm class 508. Other appropriate types of classes may also be included.

[0066] The class library 500 may include classes that each contain at least one stored sound signature or at least one set of sound attribute ranges that can be used to identify sounds that fall within the recognized class. The class library 500 may include any type of data that may be used to determine how to classify the detected sound.

[0067] The security class 502 may include sounds that involve some kind of security condition on the premise. For examples, sounds like breaking glass, breaking doors, certain types of explosives, sounds associated with a person moving in the dark, other types of sounds, gunshot sounds, yelling sounds, other types of sounds, or combinations thereof may be included in the security class.

[0068] The health condition class 504 may include sounds that indicate that a person on the building's premise is experiencing an emergency health related condition. Such sounds may include falling sounds, choking sounds, yelling sounds, explosion sounds, gunshot sounds, other types of sounds, or combinations thereof.

[0069] The property damage class 506 may be associated with sounds that include those types of sounds that indicate that damage is happening to the building. Such sounds may include breaking glass sounds, shaking sounds, breaking door sounds, flooding sounds, explosion sounds, cracking sounds, other types of sounds, or combinations thereof.

[0070] The alarm class 508 may include those sounds that are associated with alarm sounds in the building. Such alarm sounds may include fire alarm sounds, carbon monoxide alarm sounds, security alarm sounds, weather alarm sounds, earthquake alarm sounds, other types of alarm sounds, or combinations thereof.

[0071] The systems and methods described herein relate to building and residential automation and security systems. More specifically, the systems and methods described herein relate to detecting occupancy of a building in relation to a building and residential automation system. Some embodiments of the systems and methods described herein relate to detecting occupancy of a building in relation to a glass break sensor of a building or residential automation/security service.

[0072] A glass break sensor or glass break detector may be a sensor used in automation and/or security systems configured to detect when a pane of glass is shattered or broken. Glass break detectors may be used near glass doors or glass store-front windows to detect if an intruder breaks the glass to enter the premises. In some cases, glass break detectors may use a microphone. The microphone may monitor noises and vibrations in relation to a pane of glass. If the sounds or vibrations exceed a certain threshold the sounds or vibrations may be analyzed by detector circuitry. In some cases, glass break detectors may use narrowband microphones tuned to frequencies typical of glass shattering. These narrowband microphones may be configured to react to sounds above a certain threshold. In some cases, the glass break detector may compare analysis of a detected sound to one or more glass break profiles using signal transforms similar to discrete cosine transforms (DCTs) and/or fast Fourier transforms (FFTs). Such glass break detectors may react if both the amplitude threshold and statistically expressed similarity threshold are satisfied.

[0073] In some cases, glass break detectors may be located in an area of a home or business where people and/or animals may pass through. Such a glass break detector may monitor for sounds generated by passing people and/or animals. For example, a glass break detector may be mounted near a window located relative to a family room of a home. Such a home may include a number of human occupants and a pet. Glass break detectors may detect sounds generated by both the occupants as well as the pet. Thus, according to the systems and methods described herein, a glass break detector may be configured to identify human-generated sounds and animal-generated sounds. Just as the sounds and vibrations of the glass of the window are analyzed in relation to glass break profiles using signal transforms similar to DCTs and/or FFTs, the sounds generated by passing occupants and/or pets may be analyzed in relation to human and pet sound profiles. The glass break sensor may be configured to distinguish between human speech and animal sounds (*e.g.*, dog bark, cat meow, etc.), as well as distinguish between human footsteps and animal footsteps (*e.g.*, distinguish between biped footstep patterns and quadruped footstep patterns, etc.). Thus, according to the systems and methods described herein, such a glass break sensor may be configured to identify sounds as being

human-generated sounds and/or to identify sounds as being animal-generated sounds.

[0074] **FIG. 6** is a block diagram illustrating one embodiment of an environment 600 in which the present systems and methods may be implemented. In some embodiments, the systems and methods described herein may be performed on a device (*e.g.*, device 605). As depicted, the environment 600 may include a device 605, server 610, a sensor 625, a display 630, a computing device 650, an automation controller 655, and a network 615 that allows the device 605, the server 610, the computing device 650, automation controller 655, and sensor 625 to communicate with one another.

[0075] Examples of the device 605 may include any combination of a microphone, a glass break sensor, mobile devices, smart phones, personal computing devices, computers, laptops, desktops, servers, media content set top boxes, satellite set top boxes, cable set top boxes, DVRs, personal video recorders (PVRs), etc. In some cases, device 605 may include a building automation controller integrated within device 605, or as depicted, may be in communication with an automation controller via network 615. Examples of the automation controller 655 may include any device configured to control a building such as a home, a business, a government facility, etc. Accordingly, examples of automation controller 655 include any combination of a dedicated building automation computing device (*e.g.*, wall-mounted controller), a personal computing device (*e.g.*, laptop, desktop, etc.), a mobile computing device (*e.g.*, tablet computing device, smartphone, etc.), and the like. Examples of computing device 650 may include any combination of a mobile computing device, a laptop, a desktop, a server, a media set top box, etc. Examples of server 610 may include any combination of a data server, a cloud server, a server associated with an automation service provider, proxy server, mail server, web server, application server, database server, communications server, file server, home server, mobile server, name server, etc.

[0076] Examples of sensor 625 may include any combination of a camera sensor, audio sensor, forced entry sensor, shock sensor, proximity sensor, boundary sensor, light beam sensor, three-dimensional (3-D) sensor, motion sensor, smoke sensor, glass break sensor, door sensor, window sensor, carbon monoxide sensor,

accelerometer, global positioning system (GPS) sensor, Wi-Fi positioning system sensor, capacitance sensor, radio frequency sensor, near-field sensor, temperature sensor, heartbeat sensor, breathing sensor, oxygen sensor, carbon dioxide sensor, brain wave sensor, movement sensor, voice sensor, other types of sensors, actuators, or combinations thereof. Sensor 625 may represent one or more separate sensors or a combination of two or more sensors in a single device. For example, sensor 625 may represent one or more camera sensors and one or more motion sensors connected to environment 600. Sensor 625 may be integrated with an identity detection system such as a facial recognition system and/or a voice recognition system. Although sensor 625 is depicted as connecting to device 605 over network 615, in some embodiments, sensor 625 may connect directly to or within device 605.

[0077] Additionally, or alternatively, sensor 625 may be integrated with a home appliance or fixture such as a light bulb fixture. Sensor 625 may include an accelerometer to enable sensor 625 to detect a movement. For example, sensor 625 may be carried by an occupant. Sensor 625 may include a wireless communication sensor 625 configured to send and receive data and/or information to and from one or more devices in environment 600. Additionally, or alternatively, sensor 625 may include a GPS sensor to enable sensor 625 to track a location of sensor 625 attached to an occupant and/or object. Sensor 625 may include a proximity sensor to enable sensor to detect a proximity of a person relative to an object to which the sensor is attached and/or associated. In some embodiments, sensor 625 may include a forced entry sensor (*e.g.*, shock sensor, glass break sensor, etc.) to enable sensor 625 to detect an attempt to enter an area by force. Sensor 625 may include a siren to emit one or more frequencies of sound (*e.g.*, an alarm).

[0078] In some configurations, the device 605 may include a user interface 635, application 640, and occupancy detection module 645. Although the components of the device 605 are depicted as being internal to the device 605, it is understood that one or more of the components may be external to the device 605 and connect to device 605 through wired and/or wireless connections. In some embodiments, application 640 may be installed on computing device 650 in order to allow a user to interface with a function of device 605, occupancy detection module 645, automation controller 655, and/or server 610. In some cases, user interface 635

enables a user to interface with occupancy detection module 645, to configure settings in relation to the functions of occupancy detection module 645, configure a profile, configure sound signatures, capture sound samples, and the like.

[0079] In some embodiments, device 605 may communicate with server 610 via network 615. Examples of network 615 may include any combination of cloud networks, local area networks (LAN), wide area networks (WAN), virtual private networks (VPN), wireless networks (using 802.11, for example), cellular networks (using 3G and/or LTE, for example), etc. In some configurations, the network 615 may include the Internet. It is noted that in some embodiments, the device 605 may not include an occupancy detection module 645. For example, device 605 may include application 640 that allows device 605 to interface with automation controller 655 via occupancy detection module 645 located on another device such as computing device 650 and/or server 610. In some embodiments, device 605, automation controller 655, and server 610 may include an occupancy detection module 645 where at least a portion of the functions of occupancy detection module 645 are performed separately and/or concurrently on device 605, automation controller 655, and/or server 610. Likewise, in some embodiments, a user may access the functions of device 605 and/or automation controller 655 (directly or through device 605 via occupancy detection module 645) from computing device 650. For example, in some embodiments, computing device 650 includes a mobile application that interfaces with one or more functions of device 605, automation controller 655, occupancy detection module 645, and/or server 610.

[0080] In some embodiments, server 610 may be coupled to database 620. Database 620 may be internal or external to the server 610. In one example, device 605 may be coupled directly to database 620 or a database similar to database 620. Thus, database 620 may be internal or external to device 605. Database 620 may include sounds data 660. In some cases, device 605 may access sounds data 660 in database 620 over network 615 via server 610. Sounds data 660 may include data regarding algorithms for identifying sounds (*e.g.*, signal transforms such as DCTs, FFTs, etc.) such as algorithms for detecting human voice patterns, algorithms for detecting human footsteps, algorithms for detecting animal sounds, algorithms for detecting animal footsteps, etc. For instance, sounds data 660 may include

algorithms for distinguishing between footsteps of bipeds (*e.g.*, humans) and quadrupeds (*e.g.*, a pet dog, a pet cat, etc.). Sounds data 660 may include human speech signatures, human footstep signatures, signatures for one or more animals sounds (*e.g.*, dog bark, cat meow, bird chirp, etc.). Thus, in some cases, a sound detected in the building may be compared to a signature stored in database 620, and upon detecting a match, identifying the source of the sound as human and/or from a pet. In some cases, sounds data 660 may include samples of human speech, samples of animal sounds, and the like. In some cases, sounds data 660 may include samples taken from an occupant of a building and/or samples of a pet of a building, etc. Accordingly, occupancy detection module 645, in conjunction with sounds data 660, may enable the detection of occupancy of a building in relation to detected events in an automation/security system. In some embodiments, occupancy detection module 645 may perform the systems and methods described herein in conjunction with user interface 635 and/or application 640. Further details regarding the occupancy detection module 645 are discussed below.

[0081] **FIG. 7** is a block diagram illustrating one example of an occupancy detection module 645-a. Occupancy detection module 645-a may be one example of occupancy detection module 645 depicted in FIG. 6. As depicted, occupancy detection module 645-a may include monitoring module 705, a sound identification module 710, a motion detection module 715, a sound categorization module 720, and a notification module 725.

[0082] In one embodiment, monitoring module 705 may use a microphone to monitor for sounds at a building. In some embodiments, the microphone may be a glass break sensor microphone. The building may be any sort of residence, including a home, apartment, condo, etc. In some cases, the occupancy detection module 645-a may be located in a non-residential building such as a place of business, an office, a school, a church, a museum, a warehouse, a government facility, and the like. In some embodiments, occupancy detection module 645-a may be located in relation to any location with glass windows, such as a vehicle. Thus, in some cases monitoring module 705 may monitor for sounds of humans and/or pets passing by a vehicle.

[0083] Accordingly, monitoring module 705 may be configured to detect a sound via the microphone of a glass break sensor. The sound may be generated from any number of sources. In some cases, the sound may be generated by a human and/or an animal. Sound identification module 710 may determine whether the sound is made by a human or made by a pet. Sound identification module 710 may be configured to analyze a detected sound in relation to a variety of sound profiles (*e.g.*, glass break profiles, human sound profiles, animal sound profiles, etc.). Sound identification module 710 may use digital signal processing to distinguish between various sound profiles. For example, sound identification module 710 may use signal transforms such as and/or similar to DCTs and/or FFTs to analyze and distinguish between the detected sounds. In some cases, sound identification module 710 may generate sound signatures based on recorded samples of generic humans and/or generic animals. In some embodiments, sound identification module 710 may use bipedal and quadrupedal sound profiles to distinguish between and/or identify human and animal footsteps.

[0084] In one example, sound identification module 710 may be configured to generate customized sound signatures of occupants and/or pets of a building (*e.g.*, recorded samples of human speech, human footsteps, animal sounds, and/or animal footsteps). Sound identification module 710 may compare sound profiles and/or sound signatures to detected sounds in order to identify a source of the sound. Thus, in some cases, sound identification module 710 may be configured to detect the identity of the source of the sound. Upon detecting the identity of an occupant of a building, the notification module 725 may log the detected identity of the pet in a database. Upon failing to determine the identity of a detected human, the notification module 725 may log the undetected identity of the pet in a database as "unknown." Additionally, based on detecting an unknown human, an alarm may be triggered based on the settings of the automation/security system (*e.g.*, armed at night, armed away, etc.). Upon detecting a sound of a pet, the notification module 725 may log the detected identity of the pet in a database. Thus, sound identification module 710 may be configured to identify a human footstep from the sound, identify a human voice from the sound, identify an animal footstep from the sound, and/or identify an animal sound from the detected sound.

[0085] In addition to detecting individual human and individual animal sounds, sound identification module 710 may detect sounds from a human and an animal simultaneously and distinguish between the overlapping sounds to detect both human and animal sounds. In some embodiments, sound identification module 710 may determine whether the sound originates from within a building or outside the building. Thus, sound identification module 710 may detect a human and/or animal sounds originating outside a building window. Additionally, sound identification module 710 may detect human and/or animals sounds originating inside a building near the window. Thus, with an alarm set such as at night, a motion sensor may detect motion in relation to a building. In conjunction with the motion sensor, the occupancy detection module 645-a may determine that a human is passing by the outside of a building's window based on a sound generated by the human matches a human sound profile. Thus, occupancy detection module 645-a may enhance the detection capabilities of a conventional automation/security system.

[0086] In some embodiments, motion detection module 715 may detect a triggering of a motion sensor and sound categorization module 720 may analyze the sound in relation to the triggering of the motion sensor. Upon detecting the triggering of the motion sensor and determining a detected the sound is made by an animal (*e.g.*, a pet dog, cat, etc.), motion detection module 715 may ignore the triggering of the motion sensor. Thus, upon detecting a motion signature of a pet, motion detection module 715 may confirm that the detected motion originates from a pet based on the detected sounds. Accordingly, notification module 725 may forego generating a notification. Upon detecting the triggering of the motion sensor and determining the sound is made by a human, motion detection module 715 may trigger an alarm. For example, upon arming a system for night, a motion sensor may detect a motion signature of a human. Motion detection module 715 may confirm that the detected motion originates from a human based on the detected sounds. Accordingly, notification module 725 may generate a notification (*e.g.*, a notification for a security monitoring company, a notification for a police department, a notification for an occupant, etc.).

[0087] **FIG. 8** is a block diagram illustrating one example of an environment 800 for detecting occupancy of a building to improve the timely

notification regarding the detection of events. As depicted, environment 800 may include a building 805. The building 805 may include windows 815, 820, and 825. In addition to automation controller 655-a, glass break sensors 830-1, 830-2, 830-3 may be located within building 805. Automation controller 655-a may be configured to control an automation/security system of building 805. In some cases, automation controller 655-a and/or glass break sensors 830 may operate in conjunction with occupancy detection module 645. As depicted, glass break sensors 830-1 may be installed in relation to window 815, glass break sensors 830-2 may be installed in relation to window 820, and glass break sensors 830-3 may be installed in relation to window 825. Additionally, building 805 may include a motion sensor 835.

[0088] As depicted, a person 810 may be inside the building 805. Motion sensor 835 may detect the motion of person 810 moving through building 805. Additionally, the person 810 may generate sounds from human speech and/or human footsteps. The sounds generated by the person 810 may be detected by microphones on glass break sensors 830. The sounds detected by glass break sensors 830 may be analyzed to determine that the detected sounds are generated by a human (*i.e.*, person 810). Accordingly, based on the state of the security system of building 805 automation controller 655-a may trigger an alarm. For example, a state of "armed stay" (*e.g.*, armed with motion sensors disabled) and "disarmed" may not trigger an alarm upon detecting sounds generated by person 810, but "armed away" and "armed night" may trigger an alarm upon person 810 triggering motion sensor 835 and glass break sensors 830 detecting sounds from person 810. In some cases, automation controller 655-a and/or glass break sensors 830 may use passive acoustic location in order to determine a location of person 810 relative to the glass break sensors 830.

[0089] **FIG. 9** is a flow diagram illustrating one embodiment of a method 900 for detecting a premise condition. In this example, the method 900 includes detecting 902 a sound with a security system component, determining 904 with a security system component whether the sound belongs to a recognized class of sounds, and sending 906 the recognized class to a remote control unit. Such a method 900 may be implemented with a security system component 104 shown in FIGS. 1 and/or 4. In other examples, method 900 may be performed generally by the environment 100 shown in FIG. 1.

[0090] At block 902, a sound is detected with the security system component 104. Such a sound may be a sound that indicates a condition on the premise where some kind of predetermined response is desirable.

[0091] At block 904, the security system component 104 determines whether the sound belongs to a recognized class of sounds. This may be done by comparing the attributes of the detected sound with a set of sound attributes or a sound signature stored on the security system component.

[0092] At block 906, the recognized class is sent to a remote control unit 102. At the remote control unit, a decision to take action and/or what action to take is made based on the recognized class.

[0093] **FIG. 10** is a flow diagram illustrating one embodiment of a method 1000 for detecting a premise condition. In this example, the method 1000 includes detecting 1002 a sound with a security system component, determining 1004 with a security system component whether the sound belongs to a recognized class of sounds, and sending 1006 the recognized class to a remote control unit. Such a method 1000 may be implemented with a security system component 104 and a control unit 102 shown in FIGS. 1, 2 and/or 4. In other examples, method 1000 may be performed generally by the environment 100 shown in FIG. 1.

[0094] At block 1008, the remote control unit 102 causes a predetermined response to occur based on the recognized class received at the control unit 102. The predetermined class may be identified by consulting a table that associates the recognized classes with predetermined responses. Such predetermined responses may be preprogrammed responses, default responses, user selected responses, other types of responses, or combinations thereof. Such responses may include sending messages to mobile phones, control unit displays, law enforcement, medical personnel, rescue agencies, fire departments, flooding control, other devices, other organizations, or combinations thereof.

[0095] **FIG. 11** is a flow diagram illustrating one embodiment of a method 1100 for detecting a premise condition. Such a method 1100 may be implemented with a control unit and/or security system component shown in FIGS. 1, 2 and/or 4. In other examples, method 1100 may be performed generally by the environment 100 shown in FIG. 1.

[0096] At block 1102, a sound is detected and a determination 1104 is made as to whether the sound belongs to an alarm class. If the sound belongs to an alarm class, a message is sent 1106 to a user's mobile device indicating that an alarm is active on the premise. In some examples, an identification of the alarm type is included in the notification. If the sound does not belong to the alarm class, another determination 1108 is made. This determination 1108 is whether the sound belongs to a security class. If the sound belongs to the security class, a message is sent 1110 to law enforcement personnel. In some examples, an identification of the security sound type is included in the notification to law enforcement.

[0097] If the sound does not belong to a security class, a determination 1112 is made to whether the sound belongs to a health condition class. If the sound belongs to the health condition class, a message is sent to medical personnel, such as a nurse, ambulance, emergency room, other types of medical facilities, or combinations thereof. In some examples, an identification of the health related sound type is included in the notification to the medical personnel.

[0098] If the sound does not belong to a health condition class, another determination 1116 is made as to whether the sound belongs to another types of recognized class. If the sound belongs to another recognized class, then an appropriate response is performed 1118 based on the recognized class. If the sound does not belong to another type of recognized class, then the sound is disregarded 1120 by the system and no predetermined response is initiated.

[0099] While this example has been described with reference to a particular example of how to determine recognized classes and performing predetermined responses, any appropriate mechanism for determining recognized classes and executing predetermined responses may be implemented according to the principles described herein. For example, instead of sequentially evaluating the detected sounds as outlined above, the method 1100 may evaluate the sound against the criteria of each recognized class in any appropriate order. Further, more or less recognized classes may be considered than depicted in the example of FIG. 11. Additionally, while the examples above identify a single predetermined response for specific recognized classes, any appropriate number of predetermined responses and any appropriate type of predetermined response may be used in accordance with the

principles described herein. Further, in other examples, a detected sound may belong to more than one recognized class. As such, the detected sound may be compared to multiple recognized classes, even if the sound characteristics already satisfy the requisite conditions to fall within one of the recognized classes.

[00100] Further, each recognized class may include any appropriate number and types of sounds. In some examples, a recognized class may include multiple types of sounds with drastically different characteristics. For examples, a security class may include both a breaking glass sound which includes a high pitch and also a gunshot sound which includes different characteristics. In other examples, there is a different class for each of the breaking glass sounds and the gunshot sounds. Thus, a recognized class may contain a range of sounds from a single sound to hundreds of different sounds.

[00101] **FIG. 12** is a flow diagram illustrating one embodiment of a method 1200 for detecting occupancy of a building. In some configurations, the method 1200 may be implemented by the occupancy detection module 645 illustrated in FIGS. 6 and/or 7. In some configurations, the method 1200 may be implemented in conjunction with the application 640 and/or the user interface 635 illustrated in FIG. 6.

[00102] At block 1205, a microphone may be used to monitor for sounds at a building. At block 1210, a sound may be detected via the microphone. At block 1215, it may be determined whether the sound is made by a human or made by a pet.

[00103] **FIG. 13** is a flow diagram illustrating one embodiment of a method 1300 for detecting occupancy of a building. In some configurations, the method 1300 may be implemented by the occupancy detection module 645 illustrated in FIGS. 6 and/or 7. In some configurations, the method 1300 may be implemented in conjunction with the application 640 and/or the user interface 635 illustrated in FIG. 6.

[00104] At block 1305, a glass break sensor microphone may be used to monitor for sounds at a building. At block 1310, a sound may be detected via the glass break sensor microphone. At block 1315, it may be determined whether the sound is made by a human or made by a pet. At block 1320, a triggering of a motion sensor may be detected. At block 1325, upon detecting the triggering of the motion

sensor and determining the sound is made by a pet, the triggering of the motion sensor may be ignored. At block 1330, upon detecting the triggering of the motion sensor and determining the sound is made by a human, an alarm may be triggered.

[00105] **FIG. 14** depicts a block diagram of a controller 1400 suitable for implementing the present systems and methods. The controller 1400 may be an example of the control unit 102-a in FIG. 1. In one configuration, controller 1400 includes a bus 1405 which interconnects major subsystems of controller 1400, such as a central processor 1410, a system memory 1415 (typically RAM, but which may also include ROM, flash RAM, or the like), an input/output controller 1420, an external audio device, such as a speaker system 1425 via an audio output interface 1430, an external device, such as a display screen 1435 via display adapter 1440, an input device 1445 (*e.g.*, remote control device interfaced with an input controller 1450), multiple USB devices 1465 (interfaced with a USB controller 1470), one or more cellular radios 1490, and a storage interface 1480. Also included are at least one sensor 1455 connected to bus 1405 through a sensor controller 1460 and a network interface 1485 (coupled directly to bus 1405).

[00106] Bus 1405 allows data communication between central processor 1410 and system memory 1415, which may include read-only memory (ROM) or flash memory (neither shown), and random access memory (RAM) (not shown), as previously noted. The RAM is generally the main memory into which the operating system and application programs are loaded. The ROM or flash memory can contain, among other code, the Basic Input-Output system (BIOS) which controls basic hardware operation such as the interaction with peripheral components or devices. For example, a class recognition module 200-b and a response module 202-c may be used to implement the present systems and methods may be stored within the system memory 1415. These modules may be an example of the modules illustrated in FIG. 2. Applications resident with controller 1400 are generally stored on and accessed via a non-transitory computer readable medium, such as a hard disk drive (*e.g.*, fixed disk 1475) or other storage medium. Additionally, applications can be in the form of electronic signals modulated in accordance with the application and data communication technology when accessed via network interface 1485.

[00107] Storage interface 1480, as with the other storage interfaces of controller 1400, can connect to a standard computer readable medium for storage and/or retrieval of information, such as a fixed disk drive 1475. Fixed disk drive 1475 may be a part of controller 1400 or may be separate and accessed through other interface systems. Network interface 1485 may provide a direct connection to a remote server via a direct network link to the Internet via a POP (point of presence). Network interface 1485 may provide such connection using wireless techniques, including digital cellular telephone connection, Cellular Digital Packet Data (CDPD) connection, digital satellite data connection, or the like. In some embodiments, one or more sensors (*e.g.*, motion sensor, smoke sensor, glass break sensor, door sensor, window sensor, carbon monoxide sensor, and the like) connect to controller 1400 wirelessly via network interface 1485. In one configuration, the cellular radio 1490 may include a receiver and transmitter to wirelessly receive and transmit communications via, for example, a cellular network.

[00108] Many other devices or subsystems (not shown) may be connected in a similar manner (*e.g.*, entertainment system, computing device, remote cameras, wireless key fob, wall mounted user interface device, cell radio module, battery, alarm siren, door lock, lighting system, thermostat, home appliance monitor, utility equipment monitor, and so on). Conversely, all of the devices shown in FIG. 14 need not be present to practice the present systems and methods. The devices and subsystems can be interconnected in different ways from that shown in FIG. 14. The aspect of some operations of a system such as that shown in FIG. 14 are readily known in the art and are not discussed in detail in this application. Code to implement the present disclosure can be stored in a non-transitory computer-readable medium such as one or more of system memory 1415 or fixed disk 1475. The operating system provided on controller 1400 may be iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system.

[00109] **FIG. 15** depicts a block diagram of a controller 1500 suitable for implementing the present systems and methods. The controller 1500 may be an example of device 605, computing device 650, and/or automation controller 655 illustrated in FIG. 6. In one configuration, controller 1500 includes a bus 1505 which interconnects major subsystems of controller 1500, such as a central processor

1510, a system memory 1515 (typically RAM, but which may also include ROM, flash RAM, or the like), an input/output controller 1520, an external audio device, such as a speaker system 1525 via an audio output interface 1530, an external device, such as a display screen 1535 via display adapter 1540, an input device 1545 (*e.g.*, remote control device interfaced with an input controller 1550), multiple USB devices 1565 (interfaced with a USB controller 1570), and a storage interface 1580. Also included are at least one sensor 1555 connected to bus 1505 through a sensor controller 1560 and a network interface 1585 (coupled directly to bus 1505).

[00110] Bus 1505 allows data communication between central processor 1510 and system memory 1515, which may include read-only memory (ROM) or flash memory (neither shown), and random access memory (RAM) (not shown), as previously noted. The RAM is generally the main memory into which the operating system and application programs are loaded. The ROM or flash memory can contain, among other code, the Basic Input-Output system (BIOS) which controls basic hardware operation such as the interaction with peripheral components or devices. For example, the occupancy detection module 645-b to implement the present systems and methods may be stored within the system memory 1515. Applications (*e.g.*, application 640) resident with controller 1500 are generally stored on and accessed via a non-transitory computer readable medium, such as a hard disk drive (*e.g.*, fixed disk 1575) or other storage medium. Additionally, applications can be in the form of electronic signals modulated in accordance with the application and data communication technology when accessed via interface 1585.

[00111] Storage interface 1580, as with the other storage interfaces of controller 1500, can connect to a standard computer readable medium for storage and/or retrieval of information, such as a fixed disk drive 1575. Fixed disk drive 1575 may be a part of controller 1500 or may be separate and accessed through other interface systems. Network interface 1585 may provide a direct connection to a remote server via a direct network link to the Internet via a POP (point of presence). Network interface 1585 may provide such connection using wireless techniques, including digital cellular telephone connection, Cellular Digital Packet Data (CDPD) connection, digital satellite data connection, or the like. In some embodiments, one

or more sensors (*e.g.*, motion sensor, smoke sensor, glass break sensor, door sensor, window sensor, carbon monoxide sensor, and the like) connect to controller 1500 wirelessly via network interface 1585.

[00112] Many other devices or subsystems (not shown) may be connected in a similar manner (*e.g.*, entertainment system, computing device, remote cameras, wireless key fob, wall mounted user interface device, cell radio module, battery, alarm siren, door lock, lighting system, thermostat, home appliance monitor, utility equipment monitor, and so on). Conversely, all of the devices shown in FIG. 15 need not be present to practice the present systems and methods. The devices and subsystems can be interconnected in different ways from that shown in FIG. 15. The aspect of some operations of a system such as that shown in FIG. 15 are readily known in the art and are not discussed in detail in this application. Code to implement the present disclosure can be stored in a non-transitory computer-readable medium such as one or more of system memory 1515 or fixed disk 1575. The operating system provided on controller 1500 may be iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system.

[00113] Moreover, regarding the signals described herein, those skilled in the art will recognize that a signal can be directly transmitted from a first block to a second block, or a signal can be modified (e.g., amplified, attenuated, delayed, latched, buffered, inverted, filtered, or otherwise modified) between the blocks. Although the signals of the above described embodiment are characterized as transmitted from one block to the next, other embodiments of the present systems and methods may include modified signals in place of such directly transmitted signals as long as the informational and/or functional aspect of the signal is transmitted between blocks. To some extent, a signal input at a second block can be conceptualized as a second signal derived from a first signal output from a first block due to physical limitations of the circuitry involved (e.g., there will inevitably be some attenuation and delay). Therefore, as used herein, a second signal derived from a first signal includes the first signal or any modifications to the first signal, whether due to circuit limitations or due to passage through other circuit elements which do not change the informational and/or final functional aspect of the first signal.

[00114] While the foregoing disclosure sets forth various embodiments using specific block diagrams, flowcharts, and examples, each block diagram component, flowchart step, operation, and/or component described and/or illustrated herein may be implemented, individually and/or collectively, using a wide range of hardware, software, or firmware (or any combination thereof) configurations. In addition, any disclosure of components contained within other components should be considered exemplary in nature since many other architectures can be implemented to achieve the same functionality.

[00115] The process parameters and sequence of steps described and/or illustrated herein are given by way of example only and can be varied as desired. For example, while the steps illustrated and/or described herein may be shown or discussed in a particular order, these steps do not necessarily need to be performed in the order illustrated or discussed. The various exemplary methods described and/or illustrated herein may also omit one or more of the steps described or illustrated herein or include additional steps in addition to those disclosed.

[00116] Furthermore, while various embodiments have been described and/or illustrated herein in the context of fully functional computing systems, one or more of these exemplary embodiments may be distributed as a program product in a variety of forms, regardless of the particular type of computer-readable media used to actually carry out the distribution. The embodiments disclosed herein may also be implemented using software modules that perform certain tasks. These software modules may include script, batch, or other executable files that may be stored on a computer-readable storage medium or in a computing system. In some embodiments, these software modules may configure a computing system to perform one or more of the exemplary embodiments disclosed herein.

[00117] The foregoing description, for purpose of explanation, has been described with reference to specific embodiments. However, the illustrative discussions above are not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in view of the above teachings. The embodiments were chosen and described in order to best explain the principles of the present systems and methods and their practical applications, to thereby enable others skilled in the art to best utilize the present

systems and methods and various embodiments with various modifications as may be suited to the particular use contemplated.

[00118] Unless otherwise noted, the terms "a" or "an," as used in the specification and claims, are to be construed as meaning "at least one of." In addition, for ease of use, the words "including" and "having," as used in the specification and claims, are interchangeable with and have the same meaning as the word "comprising." In addition, the term "based on" as used in the specification and the claims is to be construed as meaning "based at least upon."

What is claimed is:

1. A method for detecting a premise condition, comprising:

detecting a sound with a security system component;

determining, with the security system component, whether the sound belongs to a recognized class of sounds;

sending the recognized class to a remote control unit; and

causing, with the remote control unit, a predetermined response to occur based on the recognized class.

2. The method of claim 1, wherein the security system component comprises a video camera.

3. The method of claim 1, wherein at least one recognized class is a security class.

4. The method of claim 1, wherein at least one recognized class is a health condition class.

5. The method of claim 1, wherein at least one recognized class is a property damage class.

6. The method of claim 1, wherein at least one recognized class is an alarm class.

7. The method of claim 1, wherein the sounds belonging to the recognized class comprise the sound from a group consisting of crying baby sounds above a predetermined threshold, barking dog sounds, breaking glass sounds, talking sounds, alarm sounds, or combinations thereof.

8. The method of claim 1, wherein performing the predetermined response comprises causing a security camera to exit a sleep mode.

9. The method of claim 1, wherein performing the predetermined response comprises sending a message to law enforcement.

10. The method of claim 1, wherein performing the predetermined response comprises sending a message to medical personnel.

11. The method of claim 1, wherein performing the predetermined response comprises displaying a message on a security panel.

12. The method of claim 1, wherein performing the predetermined response comprises activating an alarm.

13. The method of claim 1, wherein performing the predetermined response comprises sending a notification to a mobile device.

14. A video camera for detecting a premise condition, comprising:

a processor;

memory in electronic communication with the processor; and

instructions stored in the memory, the instructions being executable by the processor to:

detect a sound with a security system component;

determine, with the security system component, whether the sound belongs to a recognized class of sounds; and

send the recognized class to a remote control unit.

15. The video camera of claim 14, wherein the memory comprises a recognized class library.

16. The video camera of claim 15, wherein the recognized class library comprises a health condition class. a security class, a property damage class, an alarm class, or combinations thereof.

17. A computer-program product for detecting a premise condition, the computer-program product comprising a non-transitory computer-readable medium having instructions thereon, the instructions being executable by a processor to:

detect a sound with a security system component;

determine, with the security system component, whether the sound belongs to a recognized class of sounds;

send the recognized class to a remote control unit; and

cause, with the remote control unit, a predetermined response to occur based on the recognized class.

18. The computer-program product of claim 17, wherein the predetermined response comprises sending a message to law enforcement authorities.

19. The computer-program product of claim 17, wherein the predetermined response comprises sending a message to medical personnel.

20. The computer-program product of claim 17, wherein the predetermined response comprises sending a notification to a mobile device.

21. A method for detecting occupancy, comprising:

using a microphone of an automation and security system to monitor for sounds at a building;

detecting a sound via the microphone; and

determining whether the sound is made by a human or made by an animal.

22. The method of claim 21, wherein the microphone is a glass break sensor microphone.

23. The method of claim 21, further comprising:

identifying a human footstep from the sound.

24. The method of claim 21, further comprising:
identifying a human voice from the sound.

25. The method of claim 21, further comprising:
identifying an animal footstep from the sound.

26. The method of claim 21, further comprising:
identifying an animal sound from the sound.

27. The method of claim 21, further comprising:
detecting a triggering of a motion sensor; and
analyzing the sound in relation to the triggering of the motion sensor.

28. The method of claim 27, further comprising:
upon detecting the triggering of the motion sensor and determining the sound is made by the animal, ignoring the triggering of the motion sensor.

29. The method of claim 27, further comprising:
upon detecting the triggering of the motion sensor and determining the sound is made by the human, triggering an alarm.

30. The method of claim 21, further comprising:
determining whether the sound originates within the building or outside the building.

31. A microphone configured for detecting occupancy, comprising:

a processor;

memory in electronic communication with the processor, wherein the memory stores computer executable instructions that when executed by the processor cause the processor to perform the steps of:

monitoring for sounds at a building;

detecting a sound via the microphone; and

determining whether the sound is made by a human or made by an animal, the microphone being part of a home automation and security system.

32. The microphone of claim 31, wherein the microphone is a glass break sensor microphone.

33. The microphone of claim 31, wherein the instructions executed by the processor cause the processor to perform the steps of:

identifying a human footstep from the sound.

34. The microphone of claim 31, wherein the instructions executed by the processor cause the processor to perform the steps of:

identifying a human voice from the sound.

35. The microphone of claim 31, wherein the instructions executed by the processor cause the processor to perform the steps of:

identifying an animal footstep from the sound.

36. The microphone of claim 31, wherein the instructions executed by the processor cause the processor to perform the steps of:

identifying an animal sound from the sound.

37. The microphone of claim 31, wherein the instructions executed by the processor cause the processor to perform the steps of:

detecting a triggering of a motion sensor; and

analyzing the sound in relation to the triggering of the motion sensor.

38. The microphone of claim 37, wherein the instructions executed by the processor cause the processor to perform the steps of:

upon detecting the triggering of the motion sensor and determining the sound is made by the animal, ignoring the triggering of the motion sensor; and

upon detecting the triggering of the motion sensor and determining the sound is made by the human, triggering an alarm.

39. A non-transitory computer-readable storage medium storing computer executable instructions that when executed by a processor cause the processor to perform the steps of:

using a microphone of an automation and security system to monitor for sounds at a building;

detecting a sound via the microphone; and

determining whether the sound is made by a human or made by an animal.

40. The non-transitory computer-readable storage medium of claim 39, wherein the microphone is a glass break sensor microphone.

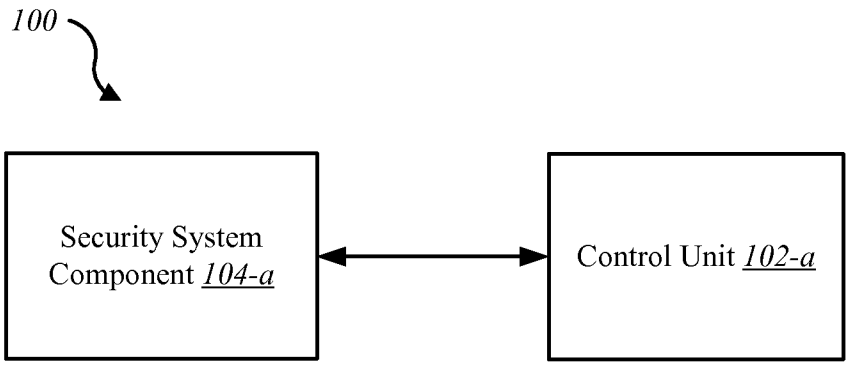

FIG. 1

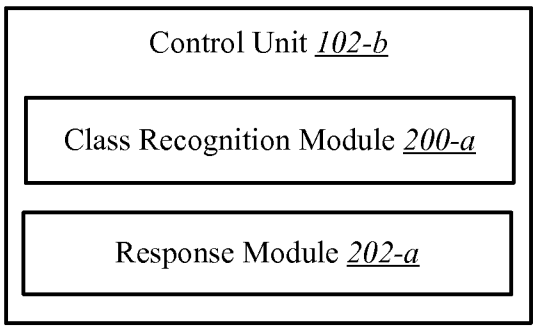
Control Unit 102-b
Class Recognition Module 200-a
Response Module 202-a

FIG. 2

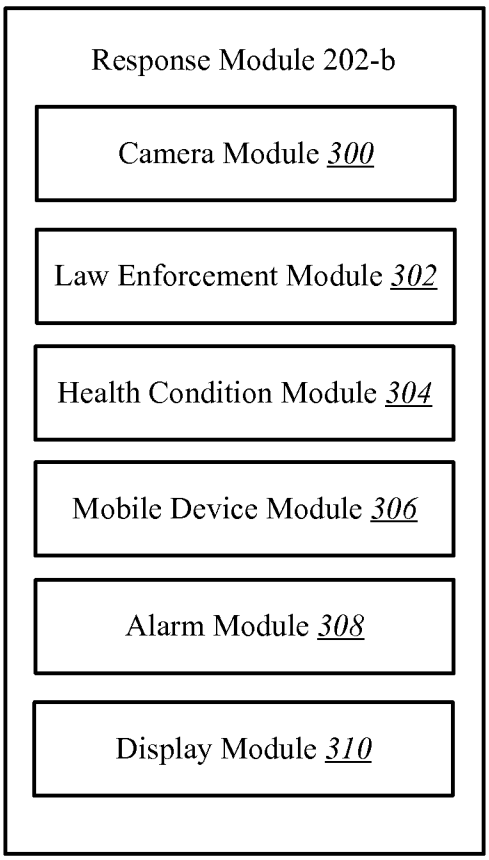
Response Module 202-b
Camera Module 300
Law Enforcement Module 302
Health Condition Module 304
Mobile Device Module 306
Alarm Module 308
Display Module 310

FIG. 3

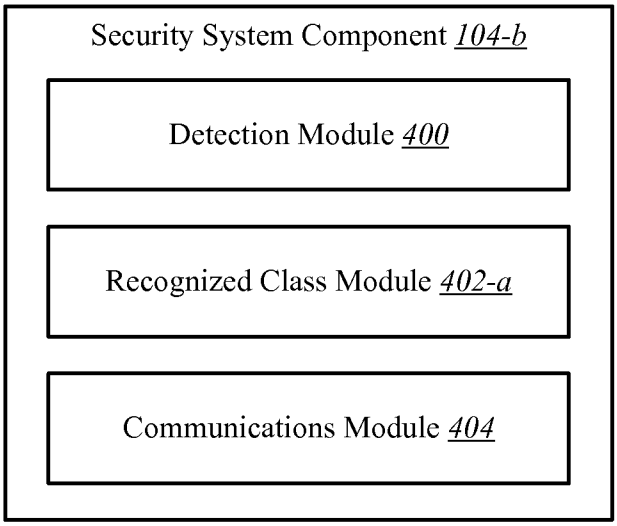
Security System Component 104-b
Detection Module 400
Recognized Class Module 402-a
Communications Module 404

FIG. 4

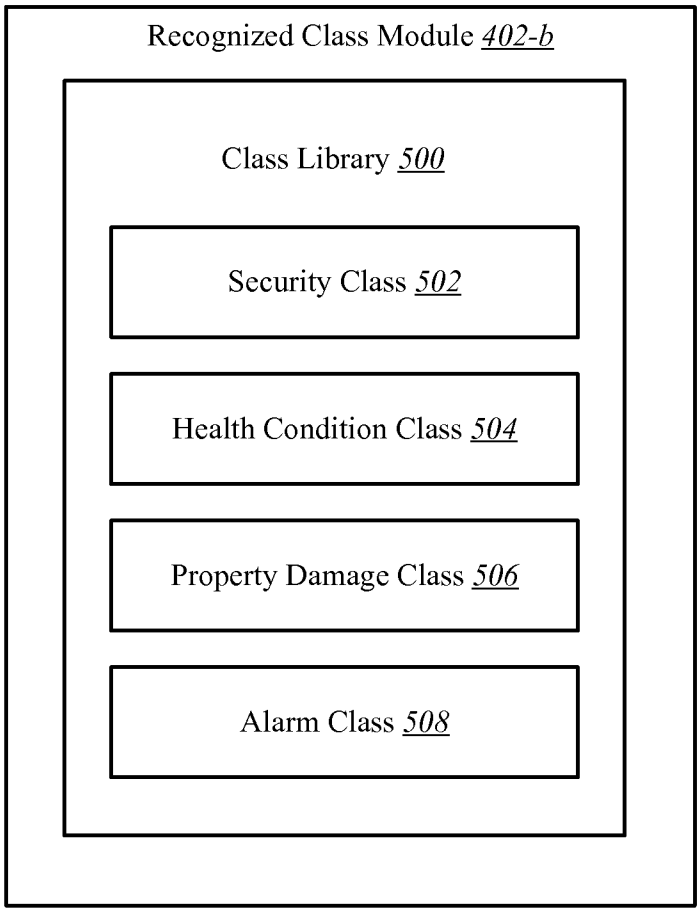
Recognized Class Module 402-b
Class Library 500
Security Class 502
Health Condition Class 504
Property Damage Class 506
Alarm Class 508

FIG. 5

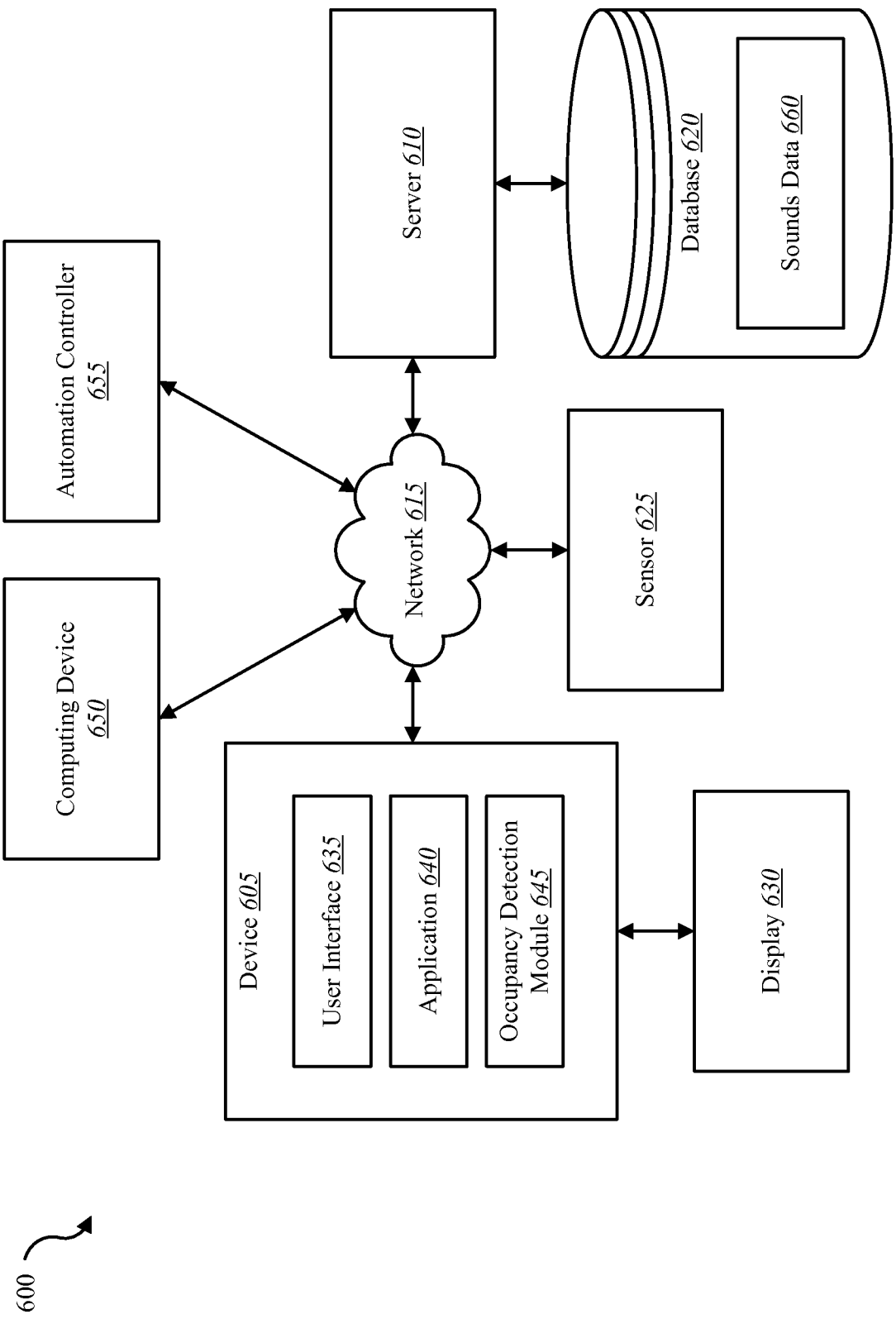
600
Server 610
Database 620
Sounds Data 660
Automation Controller 655
Network 615
Sensor 625
Computing Device 650
Device 605
User Interface 635
Application 640
Occupancy Detection Module 645
Display 630

FIG. 6

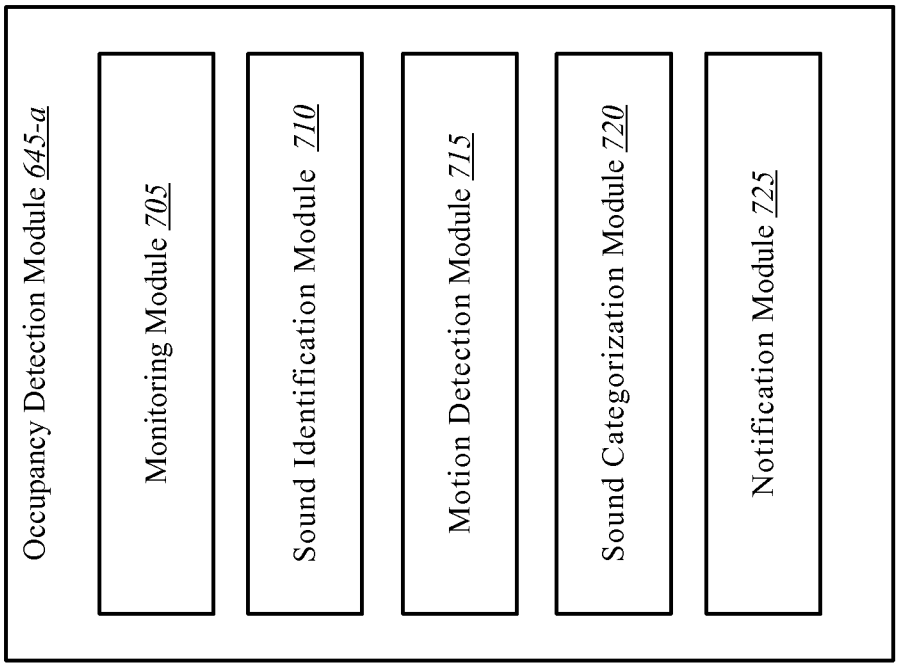
Occupancy Detection Module 645-a
Monitoring Module 705
Sound Identification Module 710
Motion Detection Module 715
Sound Categorization Module 720
Notification Module 725

FIG. 7

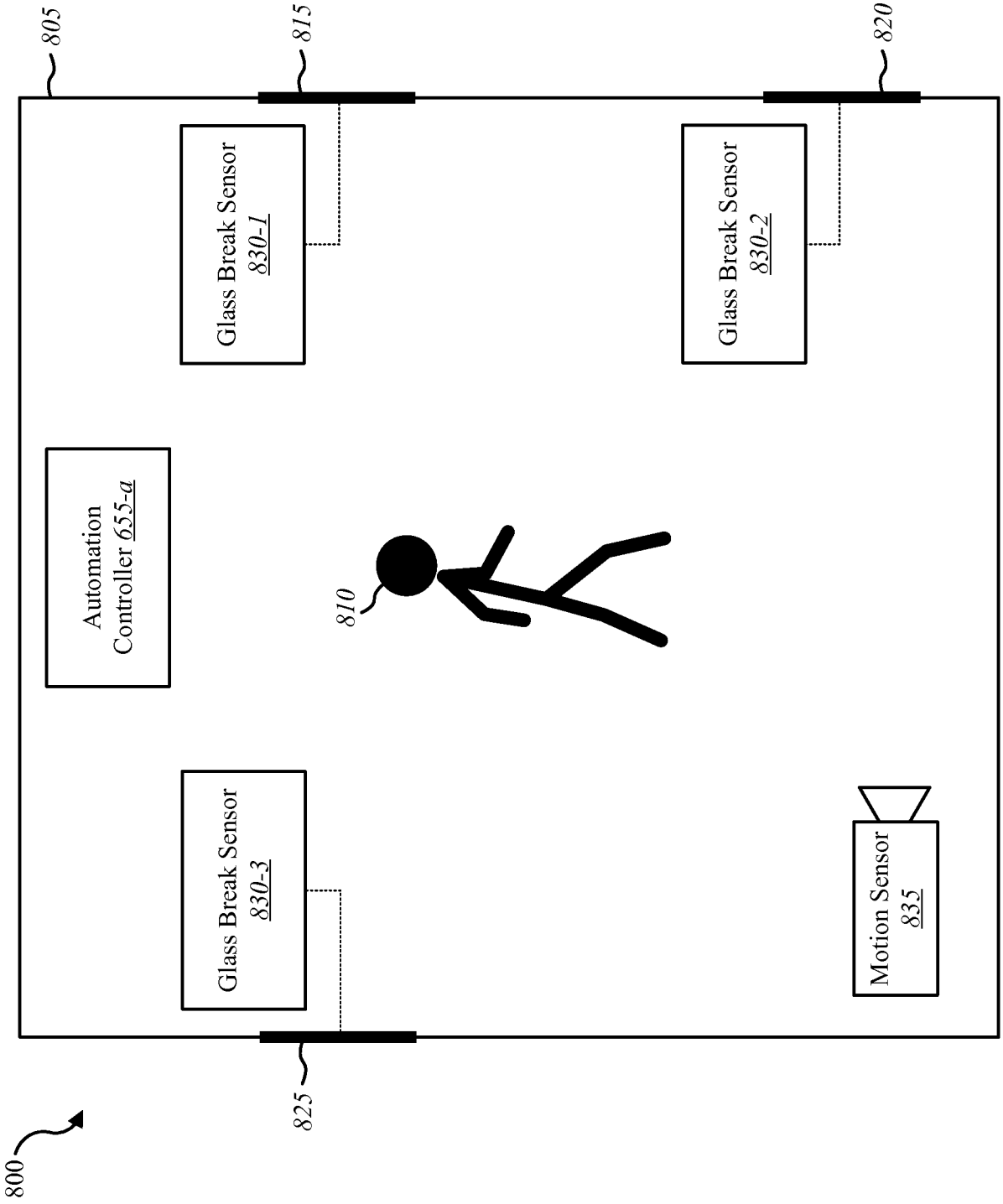
800
805
815
820
825
Glass Break Sensor 830-1
Glass Break Sensor 830-2
Glass Break Sensor 830-3
Automation Controller 655-a
810
Motion Sensor 835

FIG. 8

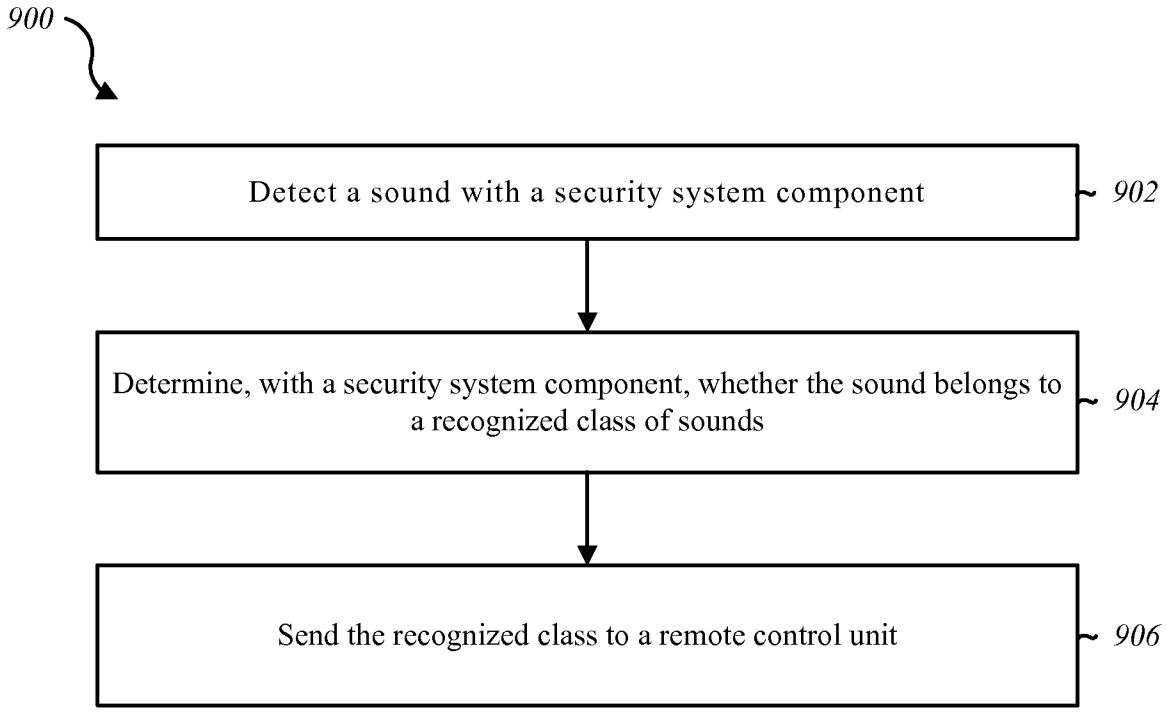
900
Detect a sound with a security system component
902
Determine, with a security system component, whether the sound belongs to a recognized class of sounds
904
Send the recognized class to a remote control unit
906

FIG. 9

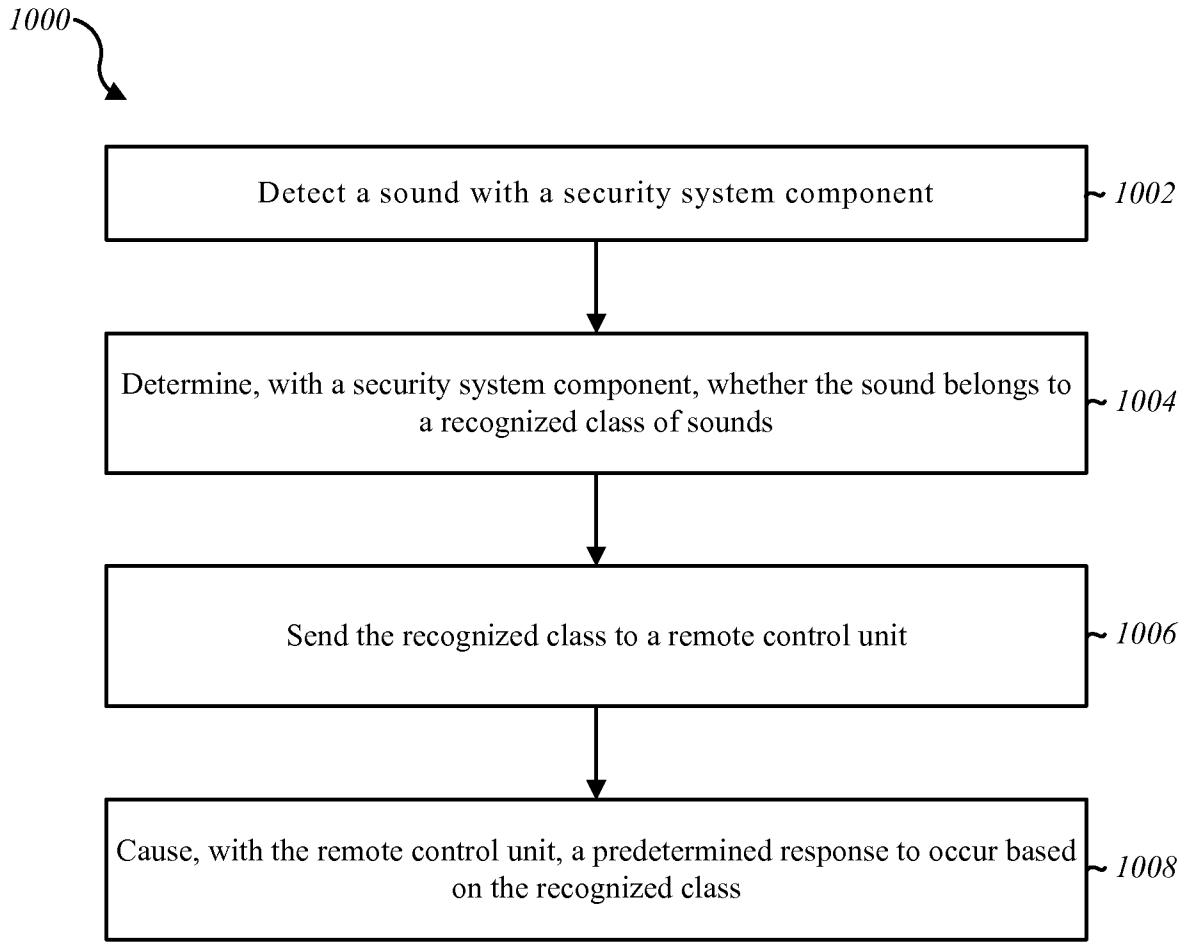
1000
Detect a sound with a security system component
1002
Determine, with a security system component, whether the sound belongs to a recognized class of sounds
1004
Send the recognized class to a remote control unit
1006
Cause, with the remote control unit, a predetermined response to occur based on the recognized class
1008

FIG. 10

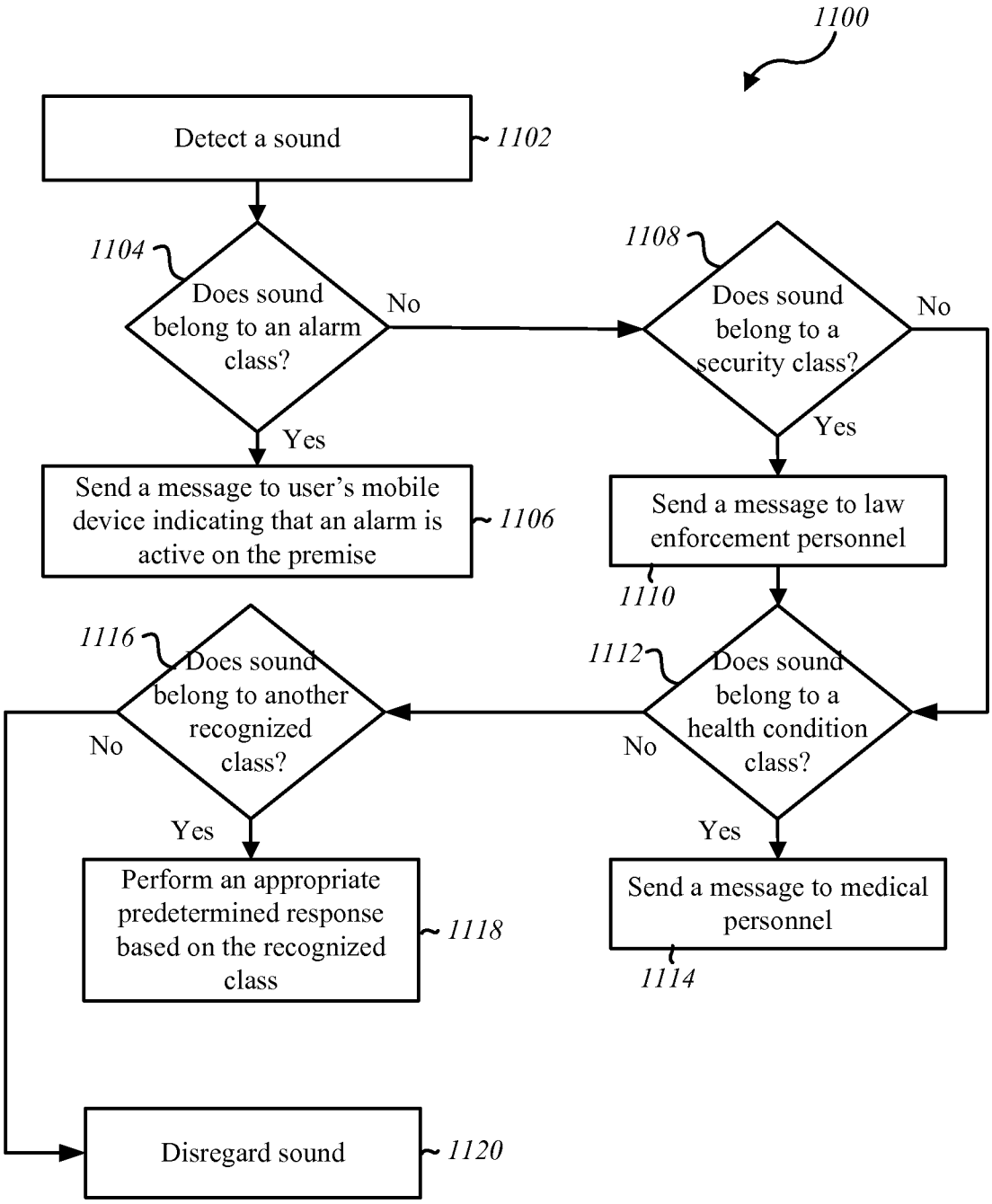
1100
Detect a sound
1102
1104
Does sound belong to an alarm class?
No
Yes
1108
Does sound belong to a security class?
No
Yes
Send a message to user's mobile device indicating that an alarm is active on the premise
1106
Send a message to law enforcement personnel
1110
1116
Does sound belong to another recognized class?
No
Yes
1112
Does sound belong to a health condition class?
No
Yes
Perform an appropriate predetermined response based on the recognized class
1118
Send a message to medical personnel
1114
Disregard sound
1120

FIG. 11

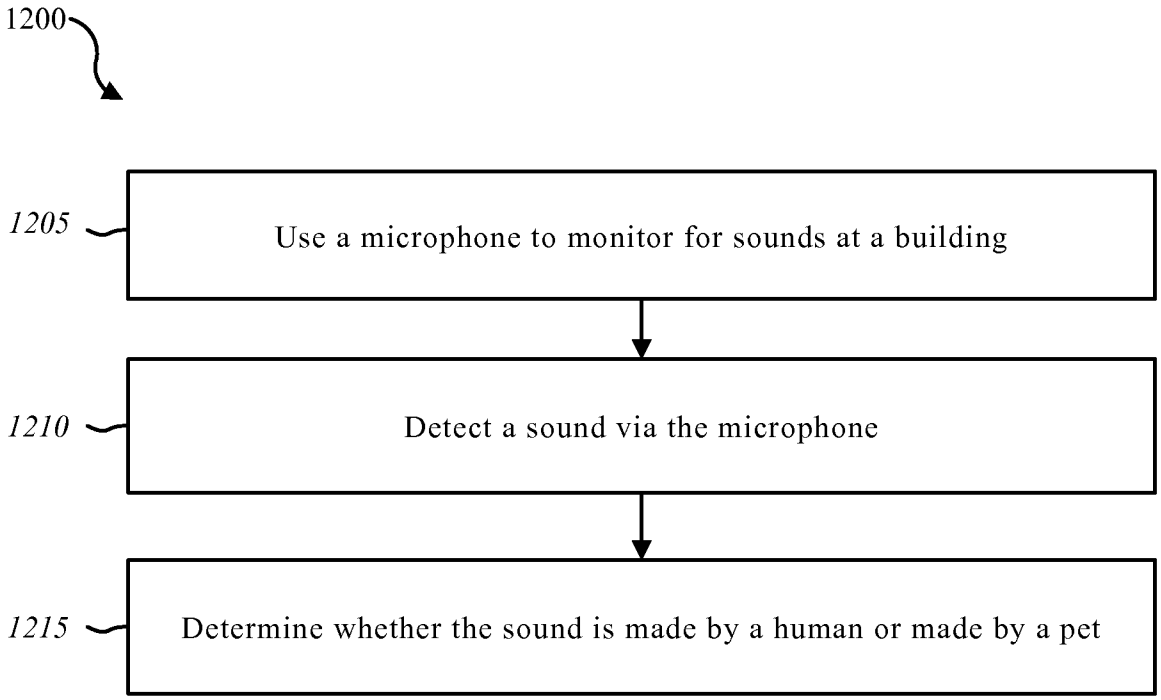
1200
1205
Use a microphone to monitor for sounds at a building
1210
Detect a sound via the microphone
1215
Determine whether the sound is made by a human or made by a pet

FIG. 12

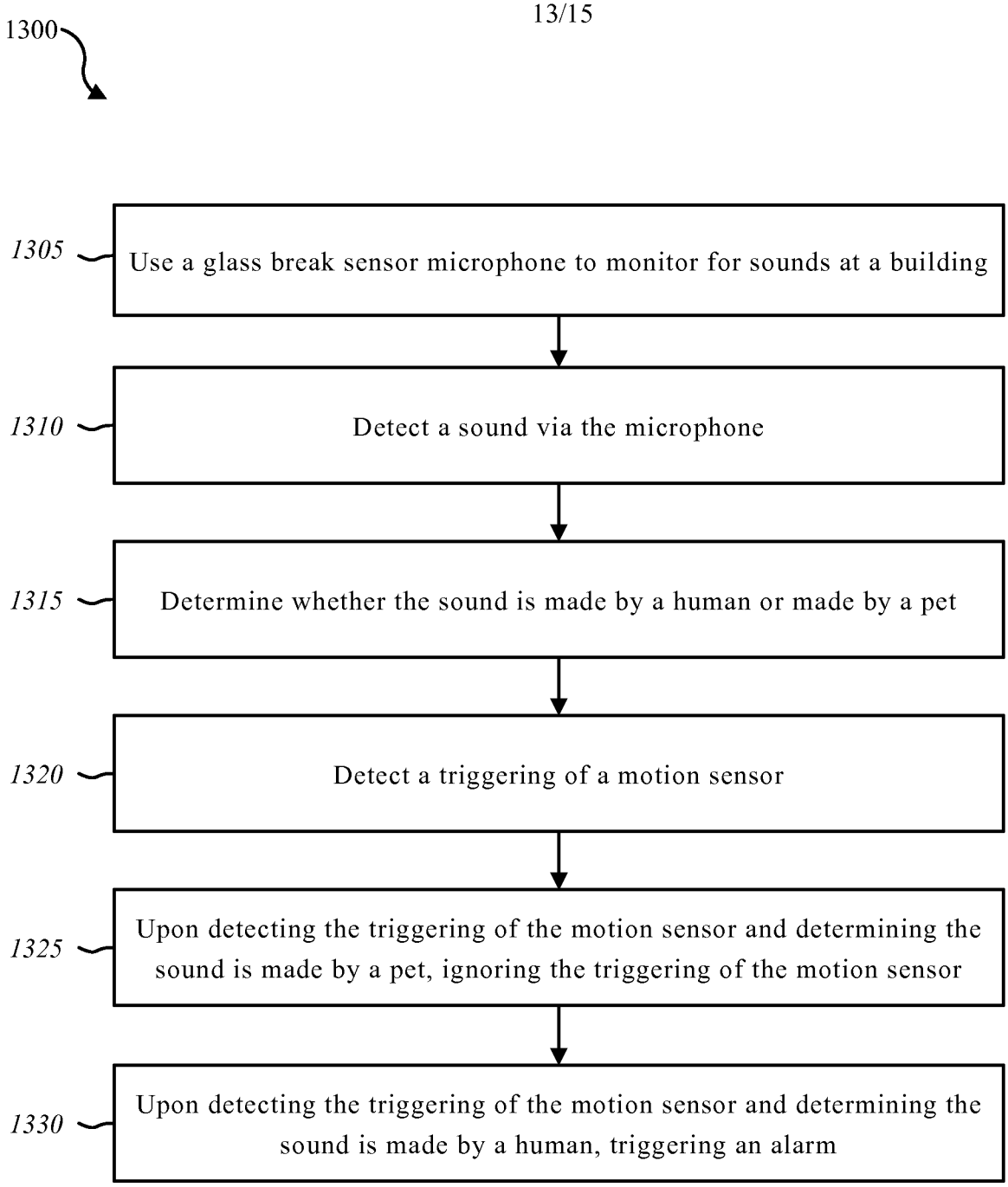
1300
1305
Use a glass break sensor microphone to monitor for sounds at a building
1310
Detect a sound via the microphone
1315
Determine whether the sound is made by a human or made by a pet
1320
Detect a triggering of a motion sensor
1325
Upon detecting the triggering of the motion sensor and determining the sound is made by a pet, ignoring the triggering of the motion sensor
1330
Upon detecting the triggering of the motion sensor and determining the sound is made by a human, triggering an alarm

FIG. 13

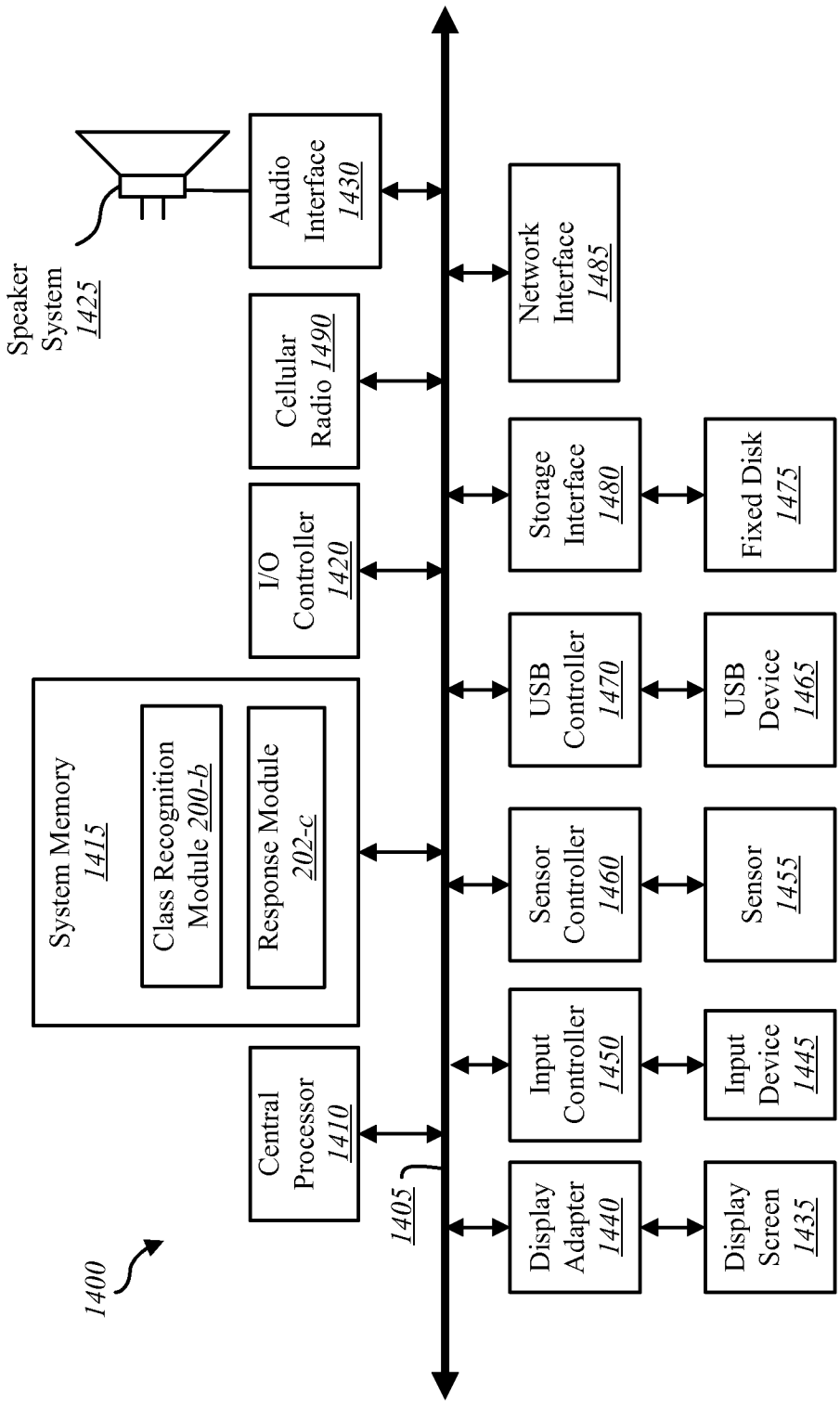
1400
1405
Central Processor 1410
System Memory 1415
Class Recognition Module 200-b
Response Module 202-c
I/O Controller 1420
Cellular Radio 1490
Audio Interface 1430
Speaker System 1425
Network Interface 1485
Storage Interface 1480
Fixed Disk 1475
USB Controller 1470
USB Device 1465
Sensor Controller 1460
Sensor 1455
Input Controller 1450
Input Device 1445
Display Adapter 1440
Display Screen 1435

FIG. 14

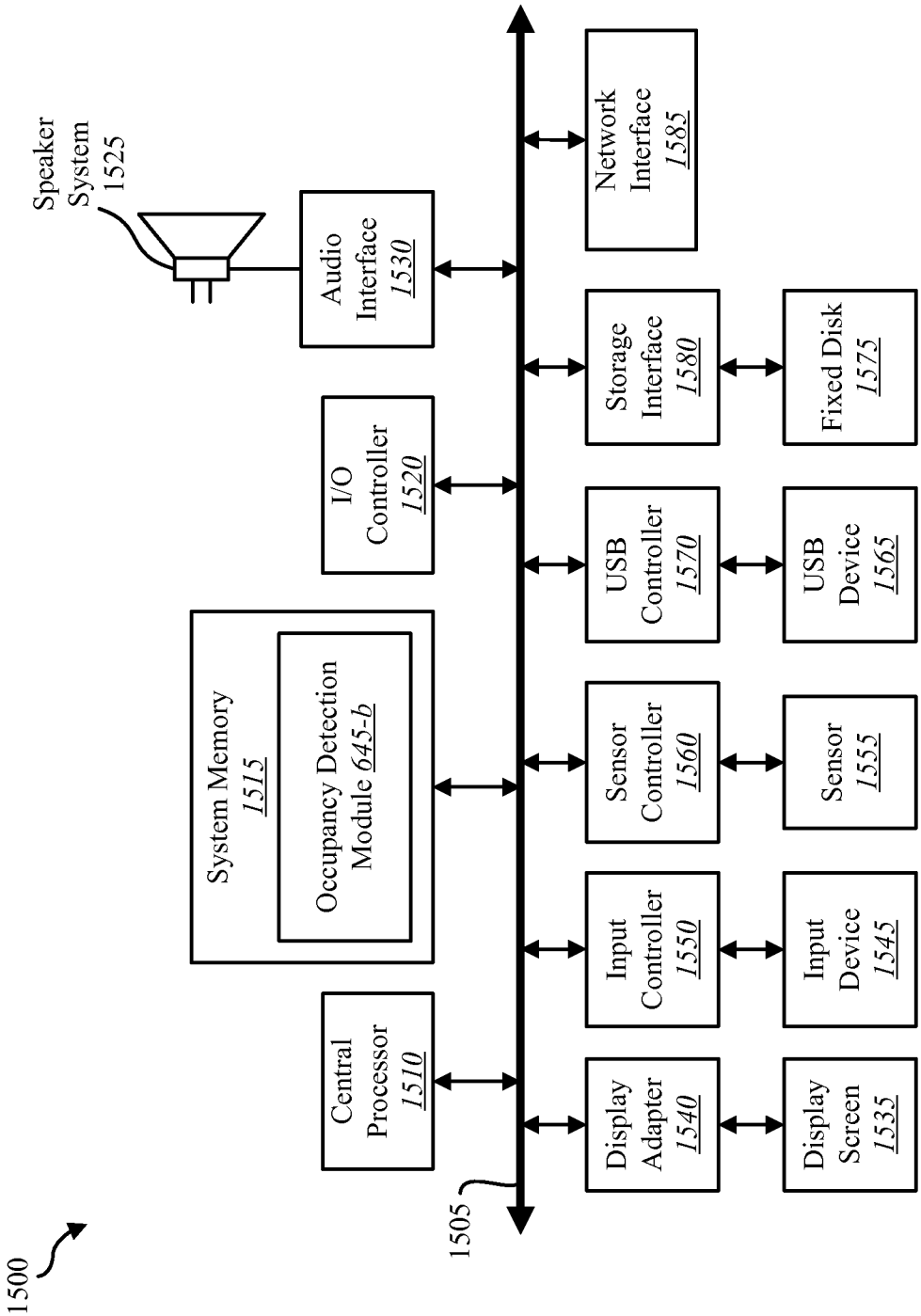
1500
1505
Speaker System 1525
Central Processor 1510
System Memory 1515
Occupancy Detection Module 645-b
I/O Controller 1520
Audio Interface 1530
Display Adapter 1540
Input Controller 1550
Sensor Controller 1560
USB Controller 1570
Storage Interface 1580
Network Interface 1585
Display Screen 1535
Input Device 1545
Sensor 1555
USB Device 1565
Fixed Disk 1575

FIG. 15

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/035119

A. CLASSIFICATION OF SUBJECT MATTER

G08B 13/196(2006.01)i, G10L 15/00(2006.01)i, G08B 3/00(2006.01)i, G08B 21/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G08B 13/196; H04M 11/04; A61B 5/00; G08B 23/00; G08B 19/02; G10L 15/00; G08B 3/00; G08B 21/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: premise condition, sound, security, determining

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2004-0151282 A1 (RUSSELL K. JONES III et al.) 05 August 2004 See paragraphs [0014]-[0036], claims 27-32 and figures 1-4.	1-40
Y	US 2007-0096927 A1 (DAVID E. ALBERT) 03 May 2007 See paragraphs [0017]-[0075], claim 1 and figures 1-6.	1-40
A	US 6134303 A (SCANNER CHEN) 17 October 2000 See abstract, column 2, line 36 - column 3, line 38 and figures 1-5.	1-40
A	US 6215404 B1 (FERNANDO MORALES) 10 April 2001 See column 4, lines 5-55, claims 1-7 and figure 2.	1-40
A	US 6204760 B1 (ROBERT BRUNIUS) 20 March 2001 See abstract, column 6, line 6 - column 8, line 49 and figures 2-3.	1-40

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2015 (28.08.2015)	**31 August 2015 (31.08.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 35208, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
LEE, Myung Jin
Telephone No. +82-42-481-8474

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2015/035119

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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US 2007-0096927 A1	03/05/2007	CA 2619797 A1	22/02/2006
		EP 1913567 A2	23/04/2008
		US 2006-0017558 A1	26/01/2006
		US 2006-0017559 A1	26/01/2006
		US 2006-0017560 A1	26/01/2006
		US 2006-0017561 A1	26/01/2006
		US 2006-0017579 A1	26/01/2006
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		US 7148797 B2	12/12/2006
		US 7170404 B2	30/01/2007
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		US 7477143 B2	13/01/2009
		US 7477144 B2	13/01/2009
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		WO 2006-012460 A3	28/06/2007
		WO 2007-021442 A1	22/02/2007
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US 6204760 B1	20/03/2001	None	