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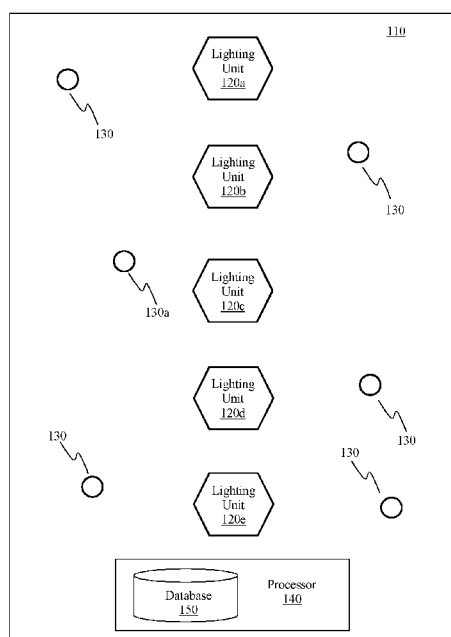


FIG. 1

(57) Abstract: A method (300) for communicating information within a lighting environment (100) using directional light includes the steps of: providing (310) a lighting system (110) comprising a plurality of lighting units configured to emit a light beam, a plurality of sound detection devices (130) configured to detect sound within the environment, and a processor (140) in communication with the lighting units and the sound detection devices; receiving (320) a navigational command to locate an item (180) within the lighting environment; detecting (330), by a sound detection device, a sound within the lighting environment; determining (340) a location of the detected sound within the lighting environment; emitting (350), by at least one of the plurality of lighting units, a first light beam (121a) in a first direction, wherein the first light beam is configured to guide a user (160) to the determined location.

Method for light guidance using sound monitoring

FIELD OF THE INVENTION

The present disclosure is directed generally to methods and systems for communicating information about monitored sound using directional light from one or more luminaires, and more specifically to directional light guidance based on sound monitoring.

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BACKGROUND

Many modern work spaces are designed to maximize interactions and utilize space more efficiently. There is a trend, for example, in many spaces to switch from working in closed offices or cubicles to working in open-offices and spaces. These open spaces typically comprise sensor-driven lighting units that monitor one or more characteristics of the environment with a sensor and utilize the sensor data to control the light source of the lighting unit. The most common example of sensor-driven lighting units are systems that monitor light levels using integrated photocells that measure ambient light levels. For example, night lights use ambient light to turn on when ambient light levels decrease and to turn off when ambient light levels increase. Similarly, many sensor-driven lighting units utilize presence detection to minimize use when no one is present.

The paradigm shift to open office spaces is unavoidably accompanied by increased noise disturbances and distractions experienced by workers within the space. Accordingly, in a number of spaces such as offices, hospitals, rehabilitation centers, and libraries, among other spaces, there are strict guidelines for maximum noise levels. This allows for interactions while minimizing the chance that an interaction between a first group of people will interrupt or affect another individual within the space, including but not limited a simultaneous interaction between a second group of people within the space.

In order to communicate information about sounds within the space, some existing smart systems monitor noise levels and provide information about that sound to individuals within the space. For example, the system may monitor noise levels and communicate a warning or signal to individuals within the space when noise levels approach or exceed a maximum desired level. However, these existing systems for communicating information to users are inefficient and ineffective. Passive sign-boards and smart signs may

provide a signal when audio levels exceed a predefined threshold, but these systems cannot communicate direct visual feedback to the sources that produce the specific disturbance.

Accordingly, there is a continued need in the art for methods and systems that efficiently and effectively communicate information about monitored sound within a space using directional light from one or more luminaires.

SUMMARY OF THE INVENTION

The present disclosure is directed to inventive methods and apparatus for communicating information about monitored sound using directional light from one or more luminaires. Various embodiments and implementations herein are directed to a system comprising a microphone array configured to monitor sound within a space, and a plurality of lighting units configured to provide granular control of light beams from one or more light sources in order to communicate information, such as guidance, to a user. The system can direct a user into, out of, or to a different spot within a space, and can direct a user to a specific location of a person, item, or other physical object or location.

Generally, in one aspect, a method for communicating information within a lighting environment using directional light is provided. The method includes the steps of: (i) providing a lighting system comprising a plurality of lighting units each configured to emit at least one light beam, a plurality of sound detection devices configured to detect sound within the lighting environment, and a processor in communication with the plurality of lighting units and the plurality of sound detection devices; (ii) receiving a navigational command to locate an item within the lighting environment; (iii) detecting, by at least one of the plurality of sound detection devices, a sound within the lighting environment; (iv) determining a location of the detected sound within the lighting environment; and (v) emitting, by at least one of the plurality of lighting units, a first light beam in a first direction, wherein the first light beam is configured to guide a user to the determined location.

According to an embodiment, the navigational command is received from the user, or is a preprogrammed command.

According to an embodiment, the method further includes the step of emitting, by at least one of the plurality of lighting units, a second light beam, wherein the second light beam is configured to guide the user to the determined location. According to an embodiment, the second light beam is emitted only when the user moves in the first direction toward the determined location.

According to an embodiment, the method further includes the step of identifying the source of the detected sound.

According to an embodiment, the method further includes the step of comparing the detected sound to a predetermined threshold. According to an embodiment, the at least one of the plurality of lighting units only emits the first light beam if the detected sound exceeds the threshold.

According to an embodiment, the item is a person, a device, or a quiet room within the lighting environment.

According to an embodiment, the method further includes the step of confirming that the user has reached the determined location.

According to an aspect is a system for communicating information within a lighting environment using directional light. The system includes: a plurality of lighting units each comprising a light source configured to emit a light beam; a plurality of sound detection devices each configured to detect a sound within the lighting environment; and a processor in communication with the plurality of lighting units and the plurality of sound detection devices, and configured to: (i) receive a navigational command to locate an item within the lighting environment; (ii) receive, from at least one of the plurality of sound detection devices, information about a detected sound; (iii) determine a location of the detected sound within the lighting environment; and (iv) direct at least one of the plurality of lighting units to emit a first light beam in a first direction, wherein the first light beam is configured to guide a user to the determined location.

According to an aspect, a method for communicating information within a lighting environment using directional light is provided. The method includes the steps of: (i) providing a lighting system comprising a plurality of lighting units each configured to emit at least one light beam, a plurality of sound detection devices configured to detect sound within the lighting environment, and a processor in communication with the plurality of lighting units and the plurality of sound detection devices; (ii) receiving a navigational command to monitor for a sound within the lighting environment; (iii) detecting, by at least one of the plurality of sound detection devices, a sound within the lighting environment; (iv) determining a location of the detected sound within the lighting environment; and (v) emitting, by at least one of the plurality of lighting units, a first light beam in a first direction, wherein the first light beam is configured to guide the user toward or away from the determined location.

As used herein for purposes of the present disclosure, the term “LED” should be understood to include any electroluminescent diode or other type of carrier injection/junction-based system that is capable of generating radiation in response to an electric signal. Thus, the term LED includes, but is not limited to, various semiconductor-based structures that emit light in response to current, light emitting polymers, organic light emitting diodes (OLEDs), electroluminescent strips, and the like. In particular, the term LED refers to light emitting diodes of all types (including semiconductor and organic light emitting diodes) that may be configured to generate radiation in one or more of the infrared spectrum, ultraviolet spectrum, and various portions of the visible spectrum (generally including radiation wavelengths from approximately 400 nanometers to approximately 700 nanometers). Some examples of LEDs include, but are not limited to, various types of infrared LEDs, ultraviolet LEDs, red LEDs, blue LEDs, green LEDs, yellow LEDs, amber LEDs, orange LEDs, and white LEDs (discussed further below). It also should be appreciated that LEDs may be configured and/or controlled to generate radiation having various bandwidths (e.g., full widths at half maximum, or FWHM) for a given spectrum (e.g., narrow bandwidth, broad bandwidth), and a variety of dominant wavelengths within a given general color categorization.

For example, one implementation of an LED configured to generate essentially white light (e.g., a white LED) may include a number of dies which respectively emit different spectra of electroluminescence that, in combination, mix to form essentially white light. In another implementation, a white light LED may be associated with a phosphor material that converts electroluminescence having a first spectrum to a different second spectrum. In one example of this implementation, electroluminescence having a relatively short wavelength and narrow bandwidth spectrum “pumps” the phosphor material, which in turn radiates longer wavelength radiation having a somewhat broader spectrum.

It should also be understood that the term LED does not limit the physical and/or electrical package type of an LED. For example, as discussed above, an LED may refer to a single light emitting device having multiple dies that are configured to respectively emit different spectra of radiation (e.g., that may or may not be individually controllable). Also, an LED may be associated with a phosphor that is considered as an integral part of the LED (e.g., some types of white LEDs). In general, the term LED may refer to packaged LEDs, non-packaged LEDs, surface mount LEDs, chip-on-board LEDs, T-package mount LEDs, radial package LEDs, power package LEDs, LEDs including some type of encasement and/or optical element (e.g., a diffusing lens), etc.

The term “light source” should be understood to refer to any one or more of a variety of radiation sources, including, but not limited to, LED-based sources (including one or more LEDs as defined above), incandescent sources (e.g., filament lamps, halogen lamps), fluorescent sources, phosphorescent sources, high-intensity discharge sources (e.g., sodium vapor, mercury vapor, and metal halide lamps), lasers, other types of electroluminescent sources, pyro-luminescent sources (e.g., flames), candle-luminescent sources (e.g., gas mantles, carbon arc radiation sources), photo-luminescent sources (e.g., gaseous discharge sources), cathode luminescent sources using electronic satiation, galvano-luminescent sources, crystallo-luminescent sources, kine-luminescent sources, thermo-luminescent sources, triboluminescent sources, sonoluminescent sources, radioluminescent sources, and luminescent polymers.

A given light source may be configured to generate electromagnetic radiation within the visible spectrum, outside the visible spectrum, or a combination of both. Hence, the terms “light” and “radiation” are used interchangeably herein. Additionally, a light source may include as an integral component one or more filters (e.g., color filters), lenses, or other optical components. Also, it should be understood that light sources may be configured for a variety of applications, including, but not limited to, indication, display, and/or illumination. An “illumination source” is a light source that is particularly configured to generate radiation having a sufficient intensity to effectively illuminate an interior or exterior space. In this context, “sufficient intensity” refers to sufficient radiant power in the visible spectrum generated in the space or environment (the unit “lumens” often is employed to represent the total light output from a light source in all directions, in terms of radiant power or “luminous flux”) to provide ambient illumination (i.e., light that may be perceived indirectly and that may be, for example, reflected off of one or more of a variety of intervening surfaces before being perceived in whole or in part).

The term “lighting fixture” is used herein to refer to an implementation or arrangement of one or more lighting units in a particular form factor, assembly, or package. The term “lighting unit” is used herein to refer to an apparatus including one or more light sources of same or different types. A given lighting unit may have any one of a variety of mounting arrangements for the light source(s), enclosure/housing arrangements and shapes, and/or electrical and mechanical connection configurations. Additionally, a given lighting unit optionally may be associated with (e.g., include, be coupled to and/or packaged together with) various other components (e.g., control circuitry) relating to the operation of the light source(s). An “LED-based lighting unit” refers to a lighting unit that includes one or more

LED-based light sources as discussed above, alone or in combination with other non LED-based light sources. A “multi-channel” lighting unit refers to an LED-based or non LED-based lighting unit that includes at least two light sources configured to respectively generate different spectrums of radiation, wherein each different source spectrum may be referred to as a “channel” of the multi-channel lighting unit.

In various implementations, a processor or controller may be associated with one or more storage media (generically referred to herein as “memory,” e.g., volatile and non-volatile computer memory such as RAM, PROM, EPROM, and EEPROM, floppy disks, compact disks, optical disks, magnetic tape, etc.). In some implementations, the storage media may be encoded with one or more programs that, when executed on one or more processors and/or controllers, perform at least some of the functions discussed herein. Various storage media may be fixed within a processor or controller or may be transportable, such that the one or more programs stored thereon can be loaded into a processor or controller so as to implement various aspects of the present invention discussed herein. The terms “program” or “computer program” are used herein in a generic sense to refer to any type of computer code (e.g., software or microcode) that can be employed to program one or more processors or controllers.

In one network implementation, one or more devices coupled to a network may serve as a controller for one or more other devices coupled to the network (e.g., in a master/slave relationship). In another implementation, a networked environment may include one or more dedicated controllers that are configured to control one or more of the devices coupled to the network. Generally, multiple devices coupled to the network each may have access to data that is present on the communications medium or media; however, a given device may be “addressable” in that it is configured to selectively exchange data with (i.e., receive data from and/or transmit data to) the network, based, for example, on one or more particular identifiers (e.g., “addresses”) assigned to it.

The term “network” as used herein refers to any interconnection of two or more devices (including controllers or processors) that facilitates the transport of information (e.g. for device control, data storage, data exchange, etc.) between any two or more devices and/or among multiple devices coupled to the network. As should be readily appreciated, various implementations of networks suitable for interconnecting multiple devices may include any of a variety of network topologies and employ any of a variety of communication protocols. Additionally, in various networks according to the present disclosure, any one connection between two devices may represent a dedicated connection between the two

systems, or alternatively a non-dedicated connection. In addition to carrying information intended for the two devices, such a non-dedicated connection may carry information not necessarily intended for either of the two devices (e.g., an open network connection).

Furthermore, it should be readily appreciated that various networks of devices as discussed herein may employ one or more wireless, wire/cable, and/or fiber optic links to facilitate information transport throughout the network.

It should be appreciated that all combinations of the foregoing concepts and additional concepts discussed in greater detail below (provided such concepts are not mutually inconsistent) are contemplated as being part of the inventive subject matter disclosed herein. In particular, all combinations of claimed subject matter appearing at the end of this disclosure are contemplated as being part of the inventive subject matter disclosed herein. It should also be appreciated that terminology explicitly employed herein that also may appear in any disclosure incorporated by reference should be accorded a meaning most consistent with the particular concepts disclosed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, like reference characters generally refer to the same parts throughout the different views. Also, the drawings are not necessarily to scale, emphasis instead generally being placed upon illustrating the principles of the invention.

FIG. 1 is a schematic representation of a lighting system, in accordance with an embodiment.

FIG. 2 is a schematic representation of a lighting system, in accordance with an embodiment.

FIG. 3 is a flowchart of a method for communicating information about sound within a lighting environment using directional light, in accordance with an embodiment.

FIG. 4 is a schematic representation of a lighting environment, in accordance with an embodiment.

FIG. 5 is a schematic representation of a lighting environment, in accordance with an embodiment.

FIG. 6 is a schematic representation of a lighting environment, in accordance with an embodiment.

FIG. 7 is a schematic representation of a lighting environment, in accordance with an embodiment.

FIG. 8 is a schematic representation of a lighting environment, in accordance with an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

5 The present disclosure describes various embodiments of a lighting system configured to communicate information about monitored sound. More generally, Applicant has recognized and appreciated that it would be beneficial to provide a lighting unit or system that monitors sound within the lighting environment using a microphone array and communicates information about that sound to one or more individuals within the lighting
10 environment using finely-tuned directional light. A particular goal of utilization of certain embodiments of the present disclosure is to provide guidance from a first point to a second point using directional light.

 In view of the foregoing, various embodiments and implementations are directed to a lighting unit or system comprising or otherwise in communication with a sound
15 detection system, such as a microphone array. The system utilizes the sound detection system to localize a person, an object, a room, or any other sound-detectable item or place. The lighting unit or system then guides an individual from a first point to a second point where the person, object, room, or other sound-detectable item or place is located. This guidance is provided by one or more lighting units configured to emit a light beam that points at the
20 detected item, and/or points in the direction of the detected item, thereby guiding the individual to and/or toward the detected item. According to various embodiments and implementations of the method and system, the individual is able to locate missing sound-detectable items, find quiet rooms, or otherwise be guided or led from a first location to a second location.

25 Referring to FIG. 1, in one embodiment, is a lighting environment 100 comprising a system 110 configured to communicate information about monitored sound using directional light from one or more lighting units. Lighting environment 100 may be, and thus system 110 may be implemented in, any internal or external setting. For example, lighting environment 100 may be a room, suite, or floor of an office building, a home, a ship,
30 a parking lot, a stadium, or any other of a wide variety of structures or settings. System 110 may be continuously active within the lighting environment, or may be activated automatically during certain times or in response to certain stimulus or triggering event. For example, a query from a user may be a trigger that activates system 110 within the lighting environment.

System 110 comprises a plurality of lighting units 120. For example, system 110 depicted in FIG. 1 comprises five lighting units (120a-120e in FIG. 1), although there may be more or fewer than five lighting units in any system. One, a plurality, or all of lighting units 120 may be configured to emit one or more light beams within the lighting environment 100. The lighting units may be further configured to adjust the direction of a light beam into one of a plurality of different directions. Accordingly, the lighting units will be able to emit a light beam in a multitude of different directions within the lighting environment.

System 110 also comprises a plurality of sound detection devices 130, such as a plurality of microphones 130 forming a microphone array. In addition to microphones, any sensor capable of detecting noise can be utilized. According to an embodiment, sound detection devices 130 are configured or structured to detect one or more sounds within the lighting environment 100. With a plurality of sound detection devices, or with a sound detection device having multiple sensors, it is possible to determine the approximate location of a sound producing item within the lighting environment.

According to an embodiment, the one or more sound detection devices 130 may also be configured to localize the source of the sound-detectable item. For example, the sensor data received from one of the plurality of sound detection devices which has detected a sound could be compared to one or more of the other devices within the system, which will provide an approximate location to the source of that detected sound. Referring to FIG. 1, for example, sound detection device 130a may detect a sound. The sound detection device and/or the system 110 may compare the sound data to sound data from one or more of the remaining sound detection devices within the system. If none of the other sound detection devices 130 detect the noise, or they detect the noise at a lower intensity, that suggests to the system that the source of the sound is in the vicinity of sound detection device 130a.

According to an embodiment, the one or more sound detection devices 130 may also be configured to identify the source of the sounds within the lighting environment 100. For example, the sound detection devices 130 and/or the system 110 may be configured to analyze the detected sound and compare it to a database of recorded sounds in order to identify the sound. For example, the system 110 may comprise a database 150 of recorded sounds, including voices of individuals expected to be within the lighting environment. Alternatively, the system 110 may be configured to identify one or more possible sources of the sound by training the system with a set of known sounds. This machine-learning type approach will enable the system to identify a wide variety of sounds.

According to an embodiment, system 110 also comprises a processor 140 configured to perform one or more processing steps or actions for the system as described or otherwise envisioned herein. For example, processor 140 may be configured to receive sensor data from the one or more sound detection devices 130, and process the sensor data to
5 identify a particular sound-detectable item or place. The processor may also be configured to cause one or more of the plurality of lighting units 120 to emit a directional light beam having a specific direction. Processor 140 may be programmed, configured, or structured to perform any of the actions or steps described herein. Processor 140 may comprise a memory or database 150, which may include one or more software programs for execution by
10 processor 140, as well as various types of data including but not limited to recorded sounds utilized for sound identification.

Referring to FIG. 2, in one embodiment, is a system 110 comprising a lighting unit 120, a microphone 130, and a processor 140. Although only a single lighting unit and microphone are depicted, the lighting system 110 may comprise a plurality of lighting units
15 and/or a plurality of microphones.

According to an embodiment, lighting unit 120 comprises one or more light sources 12, where one or more of the light sources may be an LED-based light source. Further, the LED-based light source may have one or more LEDs. The light source can be driven to emit light of predetermined character (i.e., color intensity, color temperature) by
20 one or more light source drivers 24. Many different numbers and various types of light sources (all LED-based light sources, LED-based and non-LED-based light sources alone or in combination, etc.) adapted to generate radiation of a variety of different colors may be employed in the lighting unit 120. According to an embodiment, lighting unit 120 can be any type of lighting fixture, including but not limited to a night light, a street light, a table lamp,
25 or any other interior or exterior lighting fixture.

Light source 12 can be configured to emit a directional light beam in a variety of directions within the lighting environment. For example, an array-based lighting solution can provide a steerable light beam, enabling the lighting unit to emit a beam on a small area within the entire maximum potential beam area of the lighting unit. Many other methods of
30 emitting a directional light beam are possible.

According to an embodiment, lighting unit 120 includes a controller 22 configured or programmed to output one or more signals to drive the one or more light sources 12a-d and generate varying intensities, directions, and/or colors of light from the light sources. For example, controller 22 may be programmed or configured to generate a

control signal for each light source to independently control the intensity and/or color of light generated by each light source, to control groups of light sources, or to control all light sources together. According to another aspect, the controller 22 may control other dedicated circuitry such as light source driver 24 which in turn controls the light sources so as to vary their intensities. Controller 22 can be or have, for example, a processor 26 programmed using software to perform various functions discussed herein, and can be utilized in combination with a memory 28. Memory 28 can store data, including one or more lighting commands or software programs for execution by processor 26, as well as various types of data. For example, the memory 28 may be a non-transitory computer readable storage medium that includes a set of instructions that are executable by processor 26, and which cause the system to execute one or more of the steps of the methods described herein.

Controller 22 can be programmed, structured and/or configured to cause light source driver 24 to regulate the intensity and/or color temperature of light source 12 based on predetermined data, such as ambient light conditions, among others, as will be explained in greater detail hereinafter. According to one embodiment, controller 22 can also be programmed, structured and/or configured to cause light source driver 24 to regulate the intensity and/or color temperature of light source 12 based on communications received by a communications module 34, which may be a wired or wireless communications module. According to another embodiment, controller 22 can be programmed, structured and/or configured to cause light source driver 24 to drive the light source to emit a directional beam in a specific direction within the lighting environment, such as to illuminate a certain object or space, or to otherwise orient a light beam in a specific direction as described or otherwise envisioned herein.

Lighting unit 120 also includes a source of power 30, most typically AC power, although other power sources are possible including DC power sources, solar-based power sources, or mechanical-based power sources, among others. The power source may be in operable communication with a power source converter that converts power received from an external power source to a form that is usable by the lighting unit. In order to provide power to the various components of lighting unit 120, it can also include an AC/DC converter (e.g., rectifying circuit) that receives AC power from an external AC power source 30 and converts it into direct current for purposes of powering the light unit's components. Additionally, lighting unit 120 can include an energy storage device, such as a rechargeable battery or capacitor, that is recharged via a connection to the AC/DC converter and can

provide power to controller 22 and light source driver 24 when the circuit to AC power source 30 is opened.

According to an embodiment, lighting unit 120 can communicate via a communications module 34 with one or more external transceivers. The communications module 34 may be a wired and/or wireless communications module, and can be, for example, Wi-Fi, Bluetooth, IR, radio, or near field communication that is positioned in communication with controller 22 or, alternatively, controller 22 can be integrated with the wireless communications module.

Lighting system 110 also comprises a plurality of sound detection devices 130.

According to an embodiment, the sound detection device is a microphone or any other device capable of detecting a sound or noise within the lighting environment. For example, the plurality of sound detection devices 130 may form an array, such as a microphone array, which is leveraged to identify the direction and/or location of a sound within the lighting environment. According to an embodiment, the plurality of sound detection devices may comprise a controller 42 configured or programmed to receive sensor data from the microphone or other sound sensor. The controller may also be configured or programmed to analyze the sensor data to identify the location or source of the sound, and/or configured or programmed to cause a communications module 44 of the sound detection device to transmit the sensor data or the analysis of the data to another device, including but not limited to a processor 140.

Processor 140 is configured to perform one or more processing steps or actions for the system as described or otherwise envisioned herein. For example, processor 140 may be configured to receive sensor data from the one or more sound detection devices 130, and process the sensor data to identify a particular sound-detectable item or place. The processor may also be configured to cause one or more of the plurality of lighting units 120 to emit a directional light beam having a specific direction. Processor 140 may be programmed, configured, or structured to perform any of the actions or steps described herein. Processor 140 may comprise a memory or database 150, which may include one or more software programs for execution by processor 140, as well as various types of data including but not limited to recorded sounds utilized for sound identification. Processor 140 also comprises a wired and/or wireless communications module 54, including but not limited to Wi-Fi, Bluetooth, IR, radio, or near field communication. This allows the processor to receive information from, and transmit instructions to, the lighting units 120 and the sound detection devices 130.

Although depicted as a processor in FIG. 2, processor 140 may be a component of a central hub, which may be located within the lighting environment 100, outside the lighting environment, or remote from the lighting environment. For example, a central hub may be located within a building at a location separate from the lighting environment, such as within a server room or IT department. Alternatively, the central hub may be offered as a cloud-based service, and thus may be located or hosted on one or more servers or computers remote from the lighting environment.

Referring to FIG. 3, in one embodiment, is a flowchart of a method 300 for communicating information about sound within a lighting environment 100 using directional light. In step 310 of the method, a lighting system 110 is provided. Lighting system 110 can be any of the embodiments described herein or otherwise envisioned, and can include any of the components of the lighting units 120 described in conjunction with FIGS. 1 and 2, such as one or more light sources 12, light source driver 24, controller 22, and communications module 34, among other elements. According to an embodiment, lighting system 110 is configured to emit directional light beams in one or a plurality of different directions within the lighting environment 100. Lighting system 110 also includes a plurality of sound detection devices 130, and can optionally include a processor or central hub 140.

At step 320 of the method, the lighting system 110 receives a navigational command to monitor and/or detect a specific sound or sound level within the lighting environment. According to an embodiment, the navigational command can be a predetermined or preprogrammed command or rule set. For example, the system can be configured or programmed to monitor for and detect a certain sound or sound level within the environment, such as a sound level exceeded a predetermined threshold, a predetermined unpleasant or undesirable sound or sounds, or any of a variety of other conditions, scenarios, or thresholds. The system may be programmed, modified, or otherwise configured with a threshold, rule set, or other command as a default factory setting, and/or by a user. For example, the system may be programmed or configured with a default rule or rule set, and can then be modified one or more times by the user during or after installation of the system.

According to another embodiment, the navigational command is received contemporaneously from a user 160 (shown in FIG. 4). Accordingly, lighting environment 100 and/or lighting system 110 may comprise a user interface 170 configured to receive a command from user 160. For example, user interface 170 may be a monitor or keyboard configured to receive a command from the user. Alternatively, user interface 170 may be a microphone configured to receive voice commands from the user. The system may also be

configured to receive input from a user's smartphone or other connected device, either directly or via a hosted app or third-party system.

As one example, user 160 may enter a command or otherwise request, either via a predetermined rule or a current command, that the system find the quietest available workspace within the lighting environment. The user 160 may also request that the system find a misplaced device making or capable of making a sound within the lighting environment, including a smartphone, tablet, laptop, or other portable device. As described herein, the portable device may be configured to emit a sound in order to facilitate localization by the lighting system.

As another example, user 160 may enter a command or otherwise request, either via a predetermined rule or a current command, that the system find an elevated noise level within the lighting environment. For example, the user may desire to find a meeting currently taking place somewhere within the building or on a floor. Although the user may not know the exact location, the user will recognize that the meeting will result in a significant amount of noise.

As another example, user 160 may enter a command or otherwise request, either via a predetermined rule or a current command, that the system find an individual within the lighting environment. For example, the user may want to find the last known location, based on emitted sound, of a first individual. Referring to FIG. 4, for example, user 160 is requesting via user interface 170 that the system identify the location of target individual 180, who is speaking within the lighting environment. One or more of the sound detection devices 130 in FIG. 4 may detect the target individual's speech, and as described herein, one or more of the lighting units 120 may emit a directional light beam pointed toward the target user 180.

As another example, user 160 may enter a command or otherwise request, either via a predetermined rule or a current command, that the system provide a warning to the user when the user's noise level exceeds a certain amount. For example, the user may want to keep noise below a certain level, but may have trouble doing so.

At step 330 of the method, the lighting system 110 detects a sound or sound level within the lighting environment 100 using one or more of the plurality of sound detection devices 130. For example, the sound detection devices may be microphones configured to continuously or periodically obtain sound data from the lighting environment. For example, the microphones may be located at the ceiling of the room, or may be located at approximately the level of the user, among many other locations. According to an

embodiment, the sound detection device transmits the sound data to the central hub or processor 140 for subsequent analysis. According to another embodiment, the sound detection device itself performs the subsequent analysis.

For example, a microphone 130 within the lighting environment 100 may detect an individual speaking. The microphone sends the sensor data, together with an identifier, to the central hub for analysis. According to another example, a microphone detects an alarm, chirp, or noise emitted by a smartphone, tablet, smart device, or other item. As another example, a microphone within the lighting environment may detect an absence of noise, or a level of noise above or below a certain threshold. The threshold may be predetermined or preprogrammed, or may be determined by a user.

At step 340 of the method, the system determines the location of the sound or sound level. The location can be determined simply by determining which of the sound detection devices 130 detected the identified sound, as each device will be associated with a location within the lighting environment. Referring to FIG. 1, for example, sound detection device 130a may detect a sound. The sound detection device and/or the system 110 may compare the sound data to sound data from one or more of the remaining sound detection devices within the system. If none of the other sound detection devices 130 detect the noise, or they detect the noise at a lower intensity, that suggests to the system that the source of the sound is in the vicinity of sound detection device 130a. For more specific localization, sound data from two or more devices can be utilized to triangulate the location of the sound. The localization may be probability-based, with a probability of one or more locations being calculated, and the location with the greatest probability being selected as the determined location.

According to an embodiment, sound detection device 130 detects a sound intentionally or unintentionally created by a user, such as a sound tag. These could be created during or after installation. For example, the system can detect and register a sound profile created by a specific human activity within a space and register it as a sound tag. This could be anything, such as a beeping, clapping, speaking words, or any other sound, including active and/or passive sounds. The user could, for example, associate the sound tag with an identity, or the system may automatically search a database of sounds in order to associate an identification with the sound tag. These sound tags could then be utilized for localization, navigation either toward or away from the sound tag, or for a variety of other applications including cleaning services using sound tags like broken glass or crinkling garbage to navigate to the source when cleaning is available or necessary. Many other applications are

possible. According to an embodiment, at optional step 342 of the method, the source or identify of the sound is characterized by the system. For example, the sound detection devices 130 and/or the system 110 may be configured to analyze the detected sound and compare it to a database of recorded sounds in order to identify the sound. For example, the system 110 may comprise a database 150 of recorded sounds, including voices of individuals expected to be within the lighting environment. Alternatively, the system 110 may be configured to identify one or more possible sources of the sound by training the system with a set of known sounds. The item making the sound may also emit an identifier within the sound. For example, devices can emit a coded identifier within another sound, such as a chirp or alarm, to provide an identification of the emitting device. Alternatively, a person speaking within a room may use a speech pattern, words, grammar, or other characteristics that enable identification of the speaker.

At optional step 344 of the method, the system compares the detected sound or sound level to a threshold or rule list to determine whether the detected sound satisfies one or more criteria, thus triggering the emission of a directional light beam. For example, the sound detection devices 130 and/or the processor 140 extracts information about one or more characteristics of the detected sound, such as the type of sound, intensity of the sound, the duration of the sound, and/or the frequency of the sound, among many other possible characteristics or parameters. This extracted information is compared to a threshold or rule table to determine whether the sound falls below, meets, or exceeds the threshold. The thresholds may be stored, for example, within a memory of the sound detection device 130, within a memory of the processor or central hub 140, and/or within a memory of the lighting units 120, among other locations.

At step 350 of the method, at least one of the plurality of lighting units within the lighting environment emits a first directional light beam in a first direction configured to guide a user from a first location toward or away from the determined location of the target sound or sound level. Based on the determined location of the target sound or sound level, the system determines which of the plurality of lighting units comprises a light source configured to emit a light beam at that determined location, and sends a command to emit that light beam. For example, according to an embodiment, the central hub or processor 140 sends a signal to one or more lighting units providing instructions to emit a light beam in a particular direction. The signal or instructions contain an identifier that tells which of the lighting units should respond. Controller 22 of the target lighting unit receives and implements the instructions, and directs the light driver to cause light source 12 to emit a light beam having

one or more characteristics in a particular direction. For example, if the light sources of the lighting unit are an array that are configured to point in a variety of different directions, the controller will cause the correct light source within the array to emit a light beam. According to another embodiment, each lighting unit determines individually or as a network which lighting unit and which light sources to drive. In addition to being directional, the emitted light beam can be configured in a wide variety of other ways. For example, the light beam may have a certain intensity, color, duration, and many other characteristics. Each of these characteristics is potentially selectable and/or adjustable by the lighting system.

The emitted directional light beam is configured to guide the user toward or away from the object, room, person, or other item. For example, the user will see that a directional light beam is being emitted toward a certain room, location within a room, or in some other direction. This prompts the user to follow the direction light beam toward the target object, person, or space.

According to an embodiment, the system determines which of the lighting units should emit a directional light beam based in part on the current location of the user providing the command to find the target object, person, or space. For example, the system determines that a light source close to the user will emit the directional light beam, ensuring that the user can see the beam and move toward the target.

According to an embodiment, the system determines which of the lighting units should emit a directional light beam, and in what direction, based at least in part on one or more preferences of the system. For example, the system may be programmed or configured to guide the user toward or away from a location using the one or more directional light beams in a way that minimizes additional sound by the user or the environment. Some routes, for example, may produce or result in less sound being created by the user or the environment, and the system may choose that route even if it is not the shortest or fastest route to a target item, location, or sound level. According to another embodiment, however, the system may be designed or programmed with a preference to always direct the user via the shortest or fastest route to a target item, location, or sound level.

Referring to FIG. 5, for example, user 160 requests via user interface 170 that the system identify the location of target individual 180, who is speaking within the lighting environment. One or more of the sound detection devices 130 detects the target individual's speech, and lighting unit 120a emits a first directional light beam 121a pointed toward the target user 180 and configured to guide user 160 toward target individual 180.

Similarly, in FIG. 6, user 160 requests via user interface 170 that the system guide the user to the location of target object 180, which in this example is a smartphone emitting a sound within the lighting environment. One or more of the sound detection devices 130 detects the smartphone's sound, and lighting unit 120a emits a first directional light beam 121a pointed toward the target user 180 and configured to guide user 160 toward target individual 180.

According to another embodiment of FIG. 6, user 160 preprograms the system via user interface 170 with a rule, threshold, or command. For example, the user can configure the system to guide the user by default to a target object 180, such as a smartphone, whenever it emits a certain sound such as ringing with the lighting environment. As another example, the user can pre-configure the system to guide the user by default to a target place, sound level, and/or object 180 whenever the sound level in a certain portion of the lighting environment exceeds a threshold set by the user. The user could provide this information via user interface 170, such as selecting among a list or continuum of possible thresholds and/or other options.

According to an embodiment, as the user moves toward or away from the target object, person, or space, one or more additional light sources may be controlled to emit one or more additional directional beams in order to help guide the user. This is particularly important in spaces where one directional beam is insufficient to guide a user to a distant location, such as across a large space or from one room to another room. Accordingly, at optional step 360 of the method, one of the plurality of lighting units within the lighting environment emits a second directional light beam in a direction configured to guide a user to the determined location of the target sound or sound level. This second directional light beam is generally closer to the target object, person, or space, as long as the user has been moving in the proper direction. Depending on the movement of the user, or the floorplan of the space, in some embodiments the second light beam may not be closer to the target than the first light beam. In addition to a second directional light beam, there may be a third, fourth, fifth, and so on until the user reaches the target object, person, or space.

Referring to FIG. 7, for example, user 160 has requested via user interface 170 that the system identify the location of target individual 180, who is speaking within the lighting environment. One or more of the sound detection devices 130 detected the target individual's speech, and lighting unit 120a emitted a first directional light beam 121a pointed toward the target user 180 and configured to guide user 160 toward target individual 180. The user has moved toward the target, and thus the system determines that a second light beam is

necessary to continue to guide the user toward the target. Lighting unit 120b emits a second directional light beam 121b pointed at the target individual 180. Directional light beam 121a is no longer emitted in this embodiment, although it could continue to be emitted.

Similarly, in FIG. 8, user 160 has requested via user interface 170 that the system guide the user to the location of target object 180, which in this example is a smartphone emitting a sound within the lighting environment. One or more of the sound detection devices 130 detected the smartphone's sound, and lighting unit 120a emitted a first directional light beam 121a pointed toward the target user 180 and configured to guide user 160 toward target individual 180. The user has moved toward the target, and thus the system determines that a second light beam is necessary to continue to guide the user toward the target. Lighting unit 120b emits a second directional light beam 121b pointed at the target individual 180. Directional light beam 121a is no longer emitted in this embodiment, although it could continue to be emitted.

According to an embodiment, the user observes the emitted light beam with his or her eyes, and moves in the direction of the light beam. According to another embodiment, the user wears, holds, or otherwise comprises or utilizes a light sensor configured to detect the emitted light beam. The light sensor may be a light sensor, a camera, or any other type of sensor capable of detecting a light beam and/or one or more characteristics of the emitted light beam. For example, the user may carry or wear a wearable, smartphone, tablet, or other device which can detect the emitted light beam. Accordingly, rather than or in addition to being a light beam that is newly emitted to guide the user, the light beam may comprise one or more characteristics which can be detected by the light sensor to guide the user. For example, the light beam may comprise fast light modulation, or coded light, and/or may comprise signalling outside the visible spectrum, such as near infra-red among other possibilities. This avoids the introduction of light signalling discomfort, or a distracting light beam, for example. The light sensor will detect the one or more characteristics of the light beam, and will communicate that information to the user. For example, a smartphone may detect via a light sensor coded information in a light beam, and will translate that information into directions communicated to the user via sound or a screen. Many other examples and embodiments are possible.

At optional step 370 of the method, the system may determine or confirm that the user has reached a location. This could be, for example, a sound made by the user as the target is reached. For example, the user could speak a command or other statement indicating that the target has been reached. Alternatively, the user may deactivate the sound being made

by the target object, which could then be interpreted by the system as the user having reached the item. The user may also comprise a tracking mechanism which the system can recognize or utilize to indicate that the user has reached the target location. According to an embodiment, the confirmation or determination that the user has reached the determined location will result in the one or more directional light beams being turned off, dimmed, or otherwise deactivated.

At optional step 380 of the method, the system may determine that the sound level at the user's original location, or an alternative location, has decreased to an acceptable level, and that the user can return to that original or alternative location. Accordingly, the system effectively returns to step 320 if the user directs the system to monitor for the decreased sound level, and/or to step 330 if the system is monitoring for the decreased sound level at the original or an alternative location. For example, the user may direct the system, either by pre-programming the system or giving it a new navigational commend, to let the user know when the sound level in the original location where the user began returns to an acceptable level. Alternatively, the user may want to use another room which is currently occupied or otherwise unavailable, and thus the user may direct the system, either by pre-programming the system or giving it a new navigational commend, to let the user know when the sound level in the desired room is available. The system will then proceed through the method and will guide the user to the original or desired location.

While several inventive embodiments have been described and illustrated herein, those of ordinary skill in the art will readily envision a variety of other means and/or structures for performing the function and/or obtaining the results and/or one or more of the advantages described herein, and each of such variations and/or modifications is deemed to be within the scope of the inventive embodiments described herein. More generally, those skilled in the art will readily appreciate that all parameters, dimensions, materials, and configurations described herein are meant to be exemplary and that the actual parameters, dimensions, materials, and/or configurations will depend upon the specific application or applications for which the inventive teachings is/are used. Those skilled in the art will recognize, or be able to ascertain using no more than routine experimentation, many equivalents to the specific inventive embodiments described herein. It is, therefore, to be understood that the foregoing embodiments are presented by way of example only and that, within the scope of the appended claims and equivalents thereto, inventive embodiments may be practiced otherwise than as specifically described and claimed. Inventive embodiments of the present disclosure are directed to each individual feature, system, article, material, kit,

and/or method described herein. In addition, any combination of two or more such features, systems, articles, materials, kits, and/or methods, if such features, systems, articles, materials, kits, and/or methods are not mutually inconsistent, is included within the inventive scope of the present disclosure.

5 All definitions, as defined and used herein, should be understood to control over dictionary definitions, definitions in documents incorporated by reference, and/or ordinary meanings of the defined terms.

The indefinite articles “a” and “an,” as used herein in the specification and in the claims, unless clearly indicated to the contrary, should be understood to mean “at least
10 one.”

The phrase “and/or,” as used herein in the specification and in the claims, should be understood to mean “either or both” of the elements so conjoined, i.e., elements that are conjunctively present in some cases and disjunctively present in other cases. Multiple elements listed with “and/or” should be construed in the same fashion, i.e., “one or
15 more” of the elements so conjoined. Other elements may optionally be present other than the elements specifically identified by the “and/or” clause, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, a reference to “A and/or B”, when used in conjunction with open-ended language such as “comprising” can refer, in one embodiment, to A only (optionally including elements other than B); in another
20 embodiment, to B only (optionally including elements other than A); in yet another embodiment, to both A and B (optionally including other elements); etc.

As used herein in the specification and in the claims, “or” should be understood to have the same meaning as “and/or” as defined above. For example, when separating items in a list, “or” or “and/or” shall be interpreted as being inclusive, i.e., the
25 inclusion of at least one, but also including more than one, of a number or list of elements, and, optionally, additional unlisted items. Only terms clearly indicated to the contrary, such as “only one of” or “exactly one of,” or, when used in the claims, “consisting of,” will refer to the inclusion of exactly one element of a number or list of elements. In general, the term “or” as used herein shall only be interpreted as indicating exclusive alternatives (i.e. “one or
30 the other but not both”) when preceded by terms of exclusivity, such as “either,” “one of,” “only one of,” or “exactly one of.” “Consisting essentially of,” when used in the claims, shall have its ordinary meaning as used in the field of patent law.

As used herein in the specification and in the claims, the phrase “at least one,” in reference to a list of one or more elements, should be understood to mean at least one

element selected from any one or more of the elements in the list of elements, but not necessarily including at least one of each and every element specifically listed within the list of elements and not excluding any combinations of elements in the list of elements. This definition also allows that elements may optionally be present other than the elements specifically identified within the list of elements to which the phrase “at least one” refers, whether related or unrelated to those elements specifically identified. Thus, as a non-limiting example, “at least one of A and B” (or, equivalently, “at least one of A or B,” or, equivalently “at least one of A and/or B”) can refer, in one embodiment, to at least one, optionally including more than one, A, with no B present (and optionally including elements other than B); in another embodiment, to at least one, optionally including more than one, B, with no A present (and optionally including elements other than A); in yet another embodiment, to at least one, optionally including more than one, A, and at least one, optionally including more than one, B (and optionally including other elements); etc.

It should also be understood that, unless clearly indicated to the contrary, in any methods claimed herein that include more than one step or act, the order of the steps or acts of the method is not necessarily limited to the order in which the steps or acts of the method are recited.

In the claims, as well as in the specification above, all transitional phrases such as “comprising,” “including,” “carrying,” “having,” “containing,” “involving,” “holding,” “composed of,” and the like are to be understood to be open-ended, i.e., to mean including but not limited to. Only the transitional phrases “consisting of” and “consisting essentially of” shall be closed or semi-closed transitional phrases, respectively.

CLAIMS:

1. A method (300) for communicating information within a lighting environment (100) using directional light, the method comprising the steps of:

providing (310) a lighting system (110) comprising a plurality of lighting units each configured to emit at least one light beam, a plurality of sound detection
5 devices (130) configured to detect sound within the lighting environment, and a processor (140) in communication with the plurality of lighting units and the plurality of sound detection devices;

receiving (320) a navigational command to locate an item (180) within the lighting environment;

10 detecting (330), by at least one of the plurality of sound detection devices, a sound within the lighting environment;

determining (340) a location of the detected sound within the lighting environment; and

15 emitting (350), by at least one of the plurality of lighting units, a first light beam (121a) in a first direction, wherein the first light beam is configured to guide a user (160) to the determined location by pointing in the direction of the determined location.

2. The method of claim 1, wherein the navigational command is received from the user.

20 3. The method of claim 1, wherein the navigational command is a preprogrammed command.

4. The method of claim 1, further comprising the step of emitting (360), by at
25 least one of the plurality of lighting units, a second light beam (121b), wherein the second light beam is configured to guide the user to the determined location.

5. The method of claim 1, further comprising the step of identifying (342) the source of the detected sound.

6. The method of claim 1, further comprising the step of comparing (344) the detected sound to a predetermined threshold, wherein the at least one of the plurality of lighting units only emits the first light beam if the detected sound exceeds the threshold.

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7. The method of claim 1, wherein said item is a person, a device, or a quiet room within the lighting environment.

8. The method of claim 1, further comprising the step of confirming (370) that the user has reached the determined location.

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9. A system (110) configured to communicate information within a lighting environment (100) using directional light, the system comprising:

a plurality of lighting units (120) each comprising a light source (12) configured to emit a light beam;

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a plurality of sound detection devices (130) each configured to detect a sound within the lighting environment; and

a processor (140) in communication with the plurality of lighting units and the plurality of sound detection devices, and configured to: (i) receive a navigational command to locate an item (180) within the lighting environment; (ii) receive, from at least one of the plurality of sound detection devices, information about a detected sound; (iii) determine a location of the detected sound within the lighting environment; and (iv) direct at least one of the plurality of lighting units to emit a first light beam (121a) in a first direction, wherein the first light beam is configured to guide a user (160) to the determined location by pointing in the direction of the determined location.

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10. The system of claim 9, wherein the processor is further configured to direct at least one of the plurality of lighting units to emit a second light beam (121b), wherein the second light beam is configured to guide the user to the determined location.

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11. The system of claim 9, wherein the processor is further configured to identify the source of the detected sound.

12. The system of claim 9, wherein the processor is further configured to compare the detected sound to a predetermined threshold, and further wherein the processor only directs the at least one of the plurality of lighting units to emit the first light beam if the detected sound exceeds the threshold.

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13. The system of claim 9, wherein the processor is further configured to confirm that the user has reached the determined location.

14. A method (300) for communicating information within a lighting environment (100) using directional light, the method comprising the steps of:

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providing (310) a lighting system (110) comprising a plurality of lighting units each configured to emit at least one light beam, a plurality of sound detection devices (130) configured to detect sound within the lighting environment, and a processor (140) in communication with the plurality of lighting units and the plurality of sound

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detection devices;
receiving (320) a navigational command to monitor for a sound within the lighting environment;

detecting (330), by at least one of the plurality of sound detection devices, the sound within the lighting environment;

20

determining (340) a location of the detected sound within the lighting environment;

emitting (350), by at least one of the plurality of lighting units, a first light beam (121a) in a first direction, wherein the first light beam is configured to guide a user (160) toward or away from the determined location by pointing toward or away from the

25

15. The method of claim 14, further comprising the step of emitting (360), by at least one of the plurality of lighting units, a second light beam (121b), wherein the second light beam is configured to guide the user toward or away from the determined location.

100

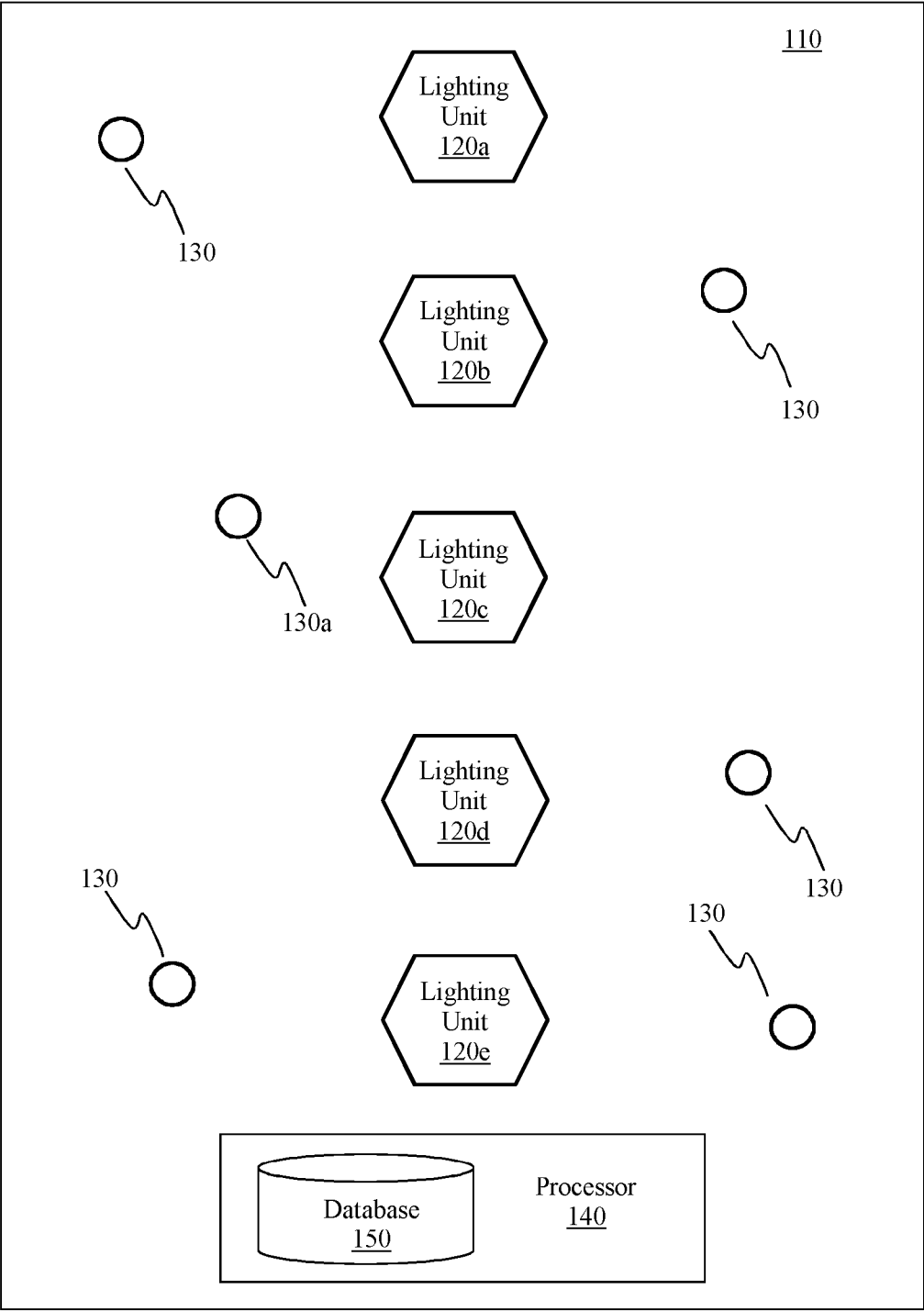


FIG. 1

110

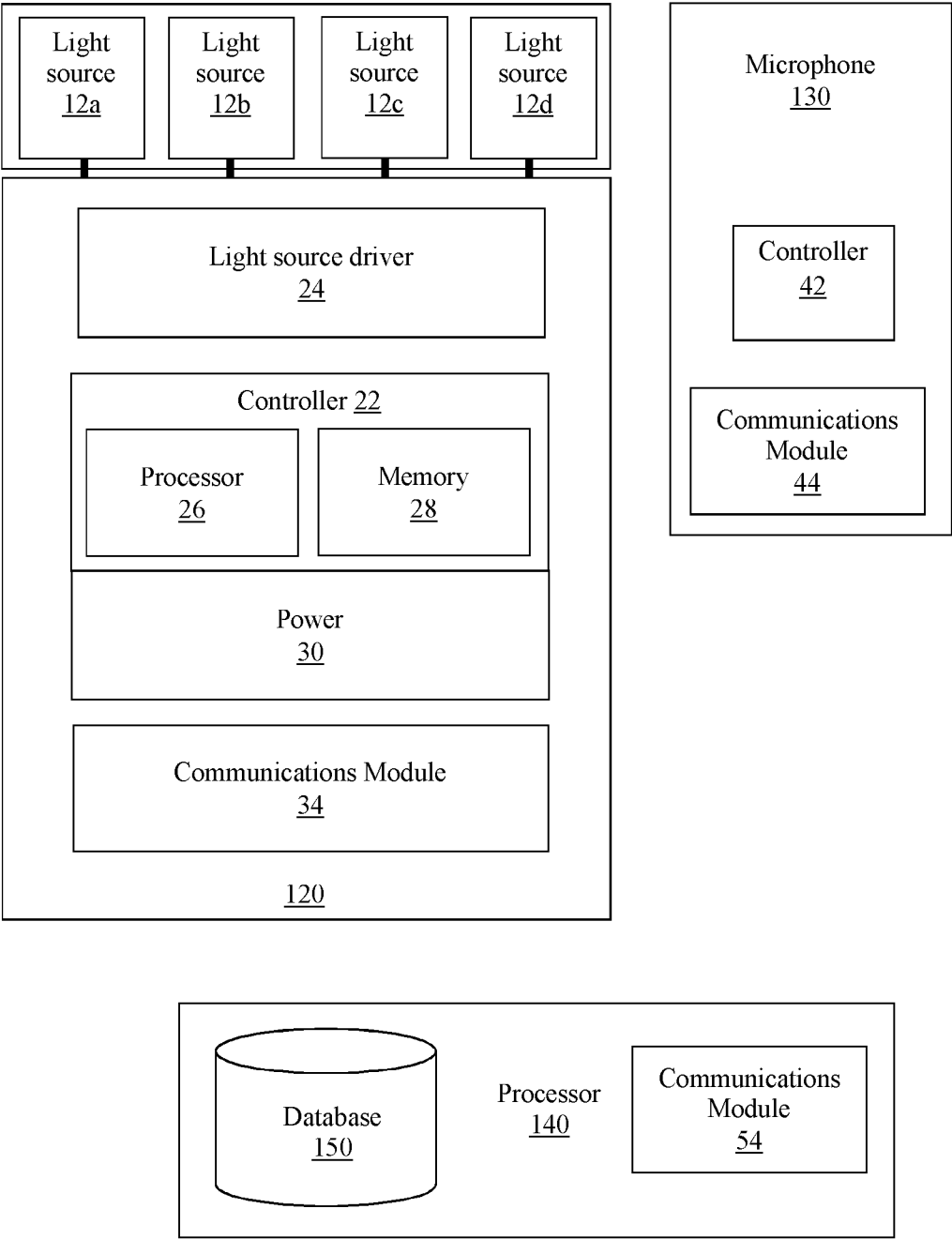


FIG. 2

300

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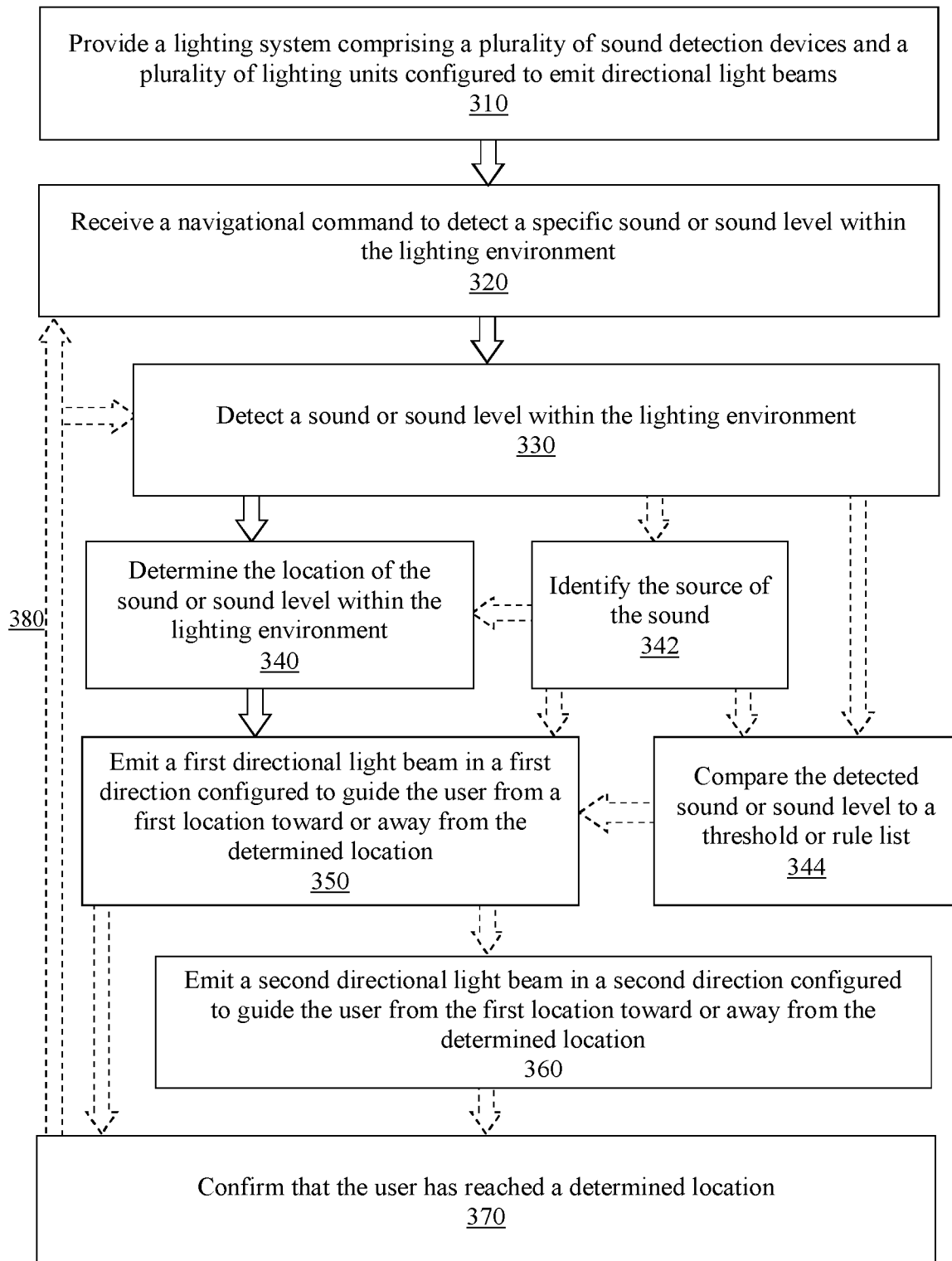


FIG. 3

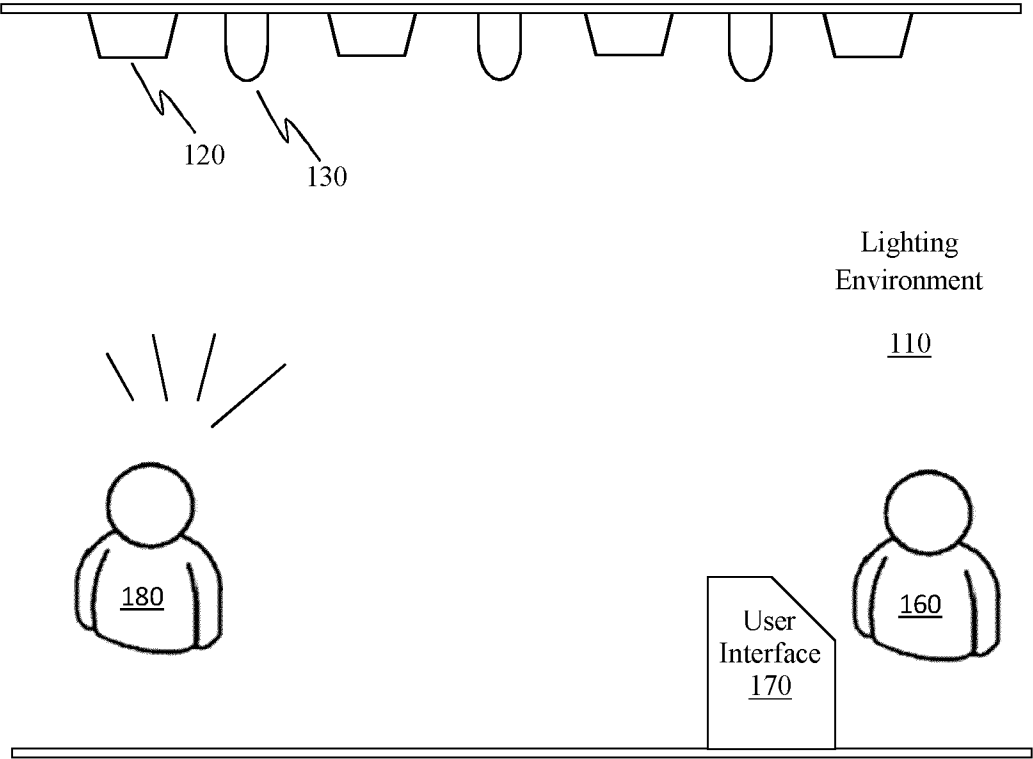


FIG. 4

5/8

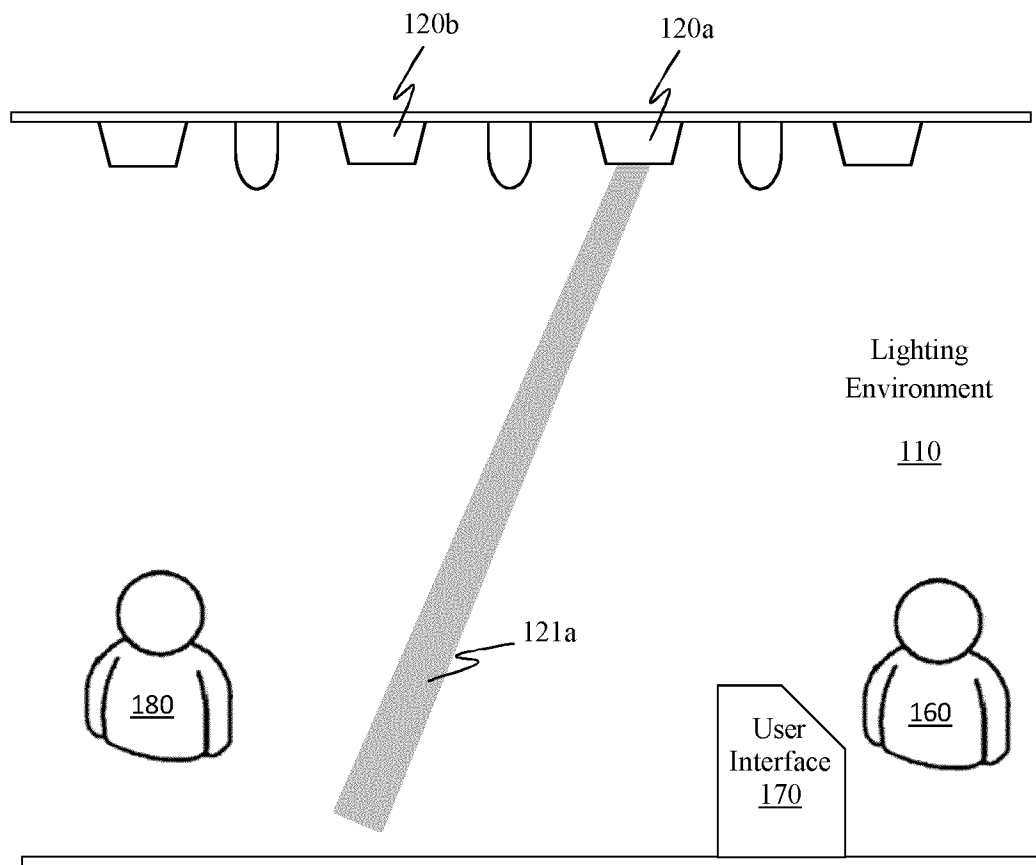


FIG. 5

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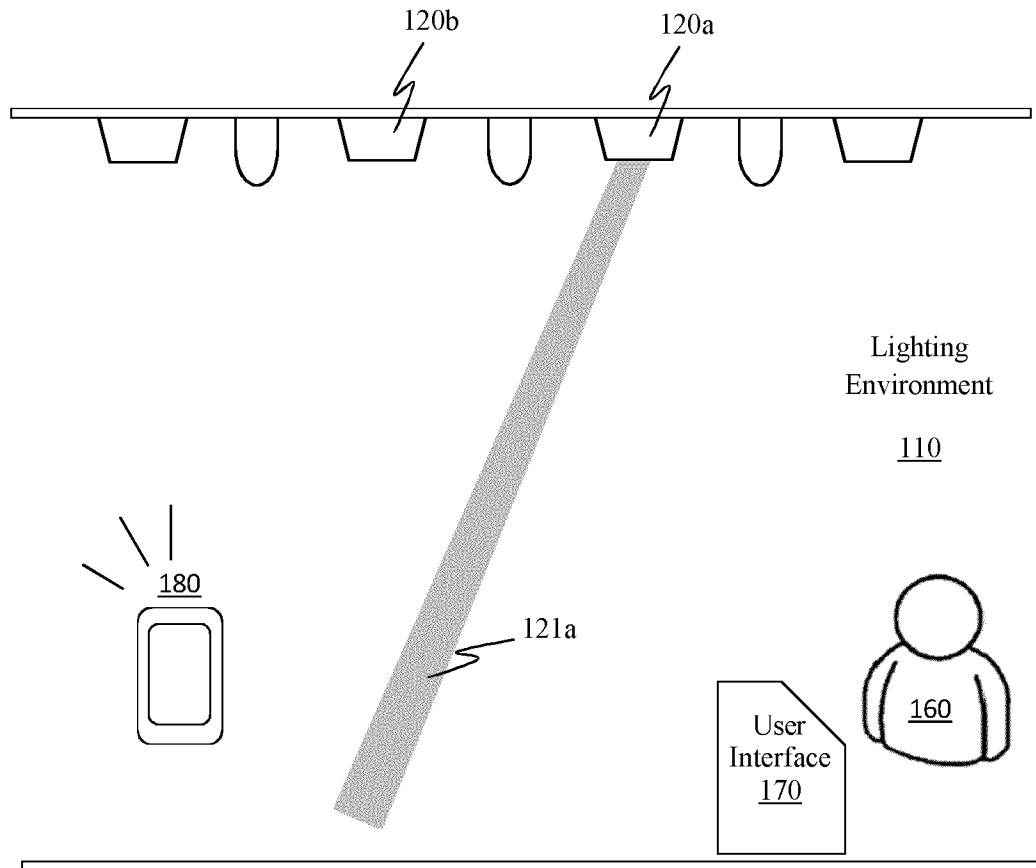


FIG. 6

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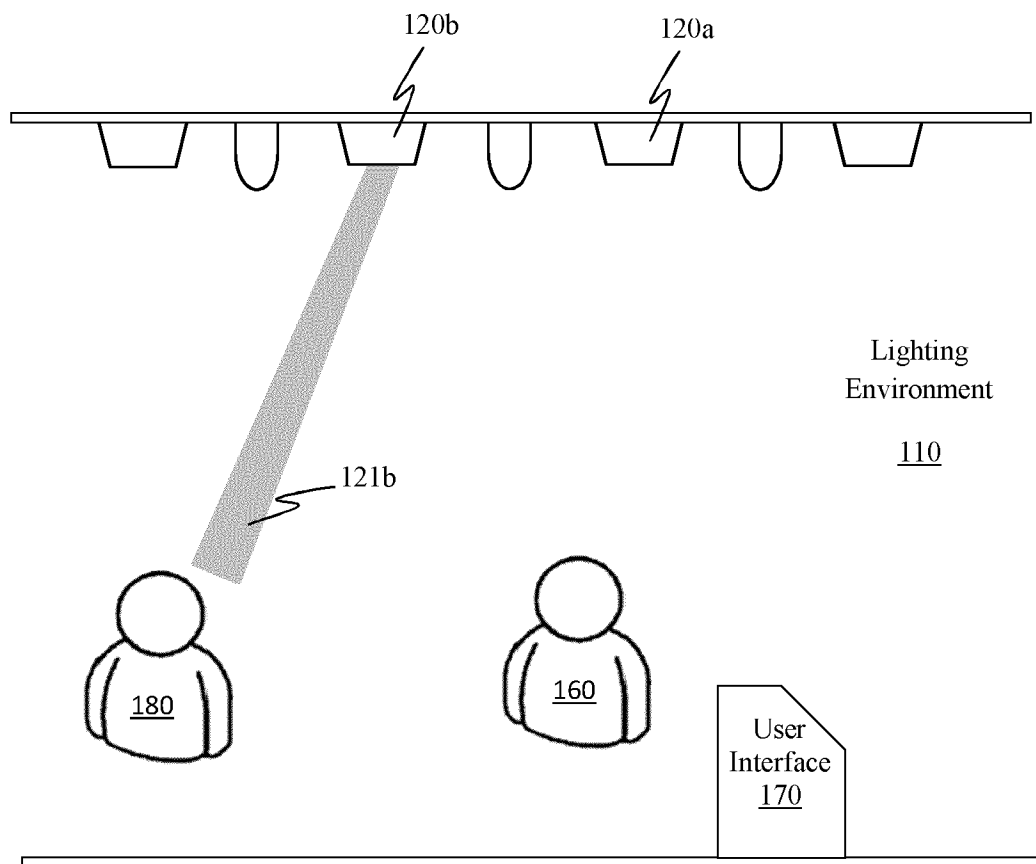


FIG. 7

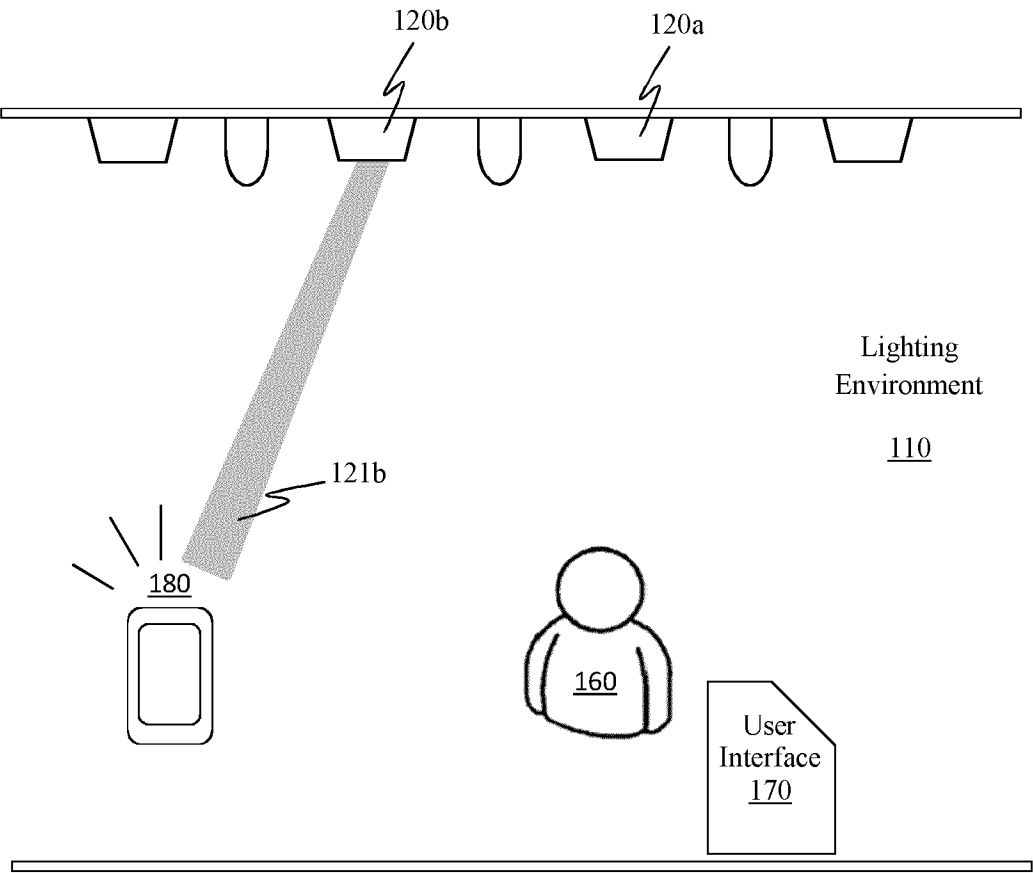


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079766

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B37/02
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 9 198 262 B1 (BOSUA PHILIP ANTHONY [AU] ET AL) 24 November 2015 (2015-11-24) figures 1,2	1-15
Y	----- WO 2010/146446 A1 (GIRLANDO DAVIDE [DE]; MANGONE ANDREA [IT]; CARLONE LUCA [IT]; BIANCHI) 23 December 2010 (2010-12-23) figure 10	1-15
Y	----- Stephen Conner ET AL: "Workplace Applications of Sensor Networks", 1 July 2004 (2004-07-01), XP055032138, Retrieved from the Internet: URL:http://www.isi.edu/~johnh/PAPERS/Conne r04a.pdf [retrieved on 2012-07-09] paragraph [0004] ----- -/-	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

9 January 2018

Date of mailing of the international search report

16/01/2018

Name and mailing address of the ISA/

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Authorized officer

Müller, Uta

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079766

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 9 332 616 B1 (MODI YASH [US] ET AL) 3 May 2016 (2016-05-03) figures 1,3A,7,8,9A -----	1-15
Y	US 2011/285854 A1 (LADUKE THOMAS F [US] ET AL) 24 November 2011 (2011-11-24) figure 3 -----	1-15
Y	US 2006/262544 A1 (PIEPGRAS COLIN [US] ET AL) 23 November 2006 (2006-11-23) paragraphs [0150] - [0153] -----	1-15
Y	WO 2013/108229 A2 (KONINKL PHILIPS NV [NL]) 25 July 2013 (2013-07-25) figure 2 -----	5,11
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Y	WO 2012/160467 A1 (KONINKL PHILIPS ELECTRONICS NV [NL]; MASON JONATHAN DAVID [NL]; ALIAKS) 29 November 2012 (2012-11-29) figures 1-4,10 -----	1-15
Y	US 2016/284177 A1 (LO PAUL [CN] ET AL) 29 September 2016 (2016-09-29) paragraphs [0086], [0089]; figures 6A, 6B,7,8 -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/079766

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 9198262	B1	24-11-2015	US 9198262 B1 24-11-2015
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