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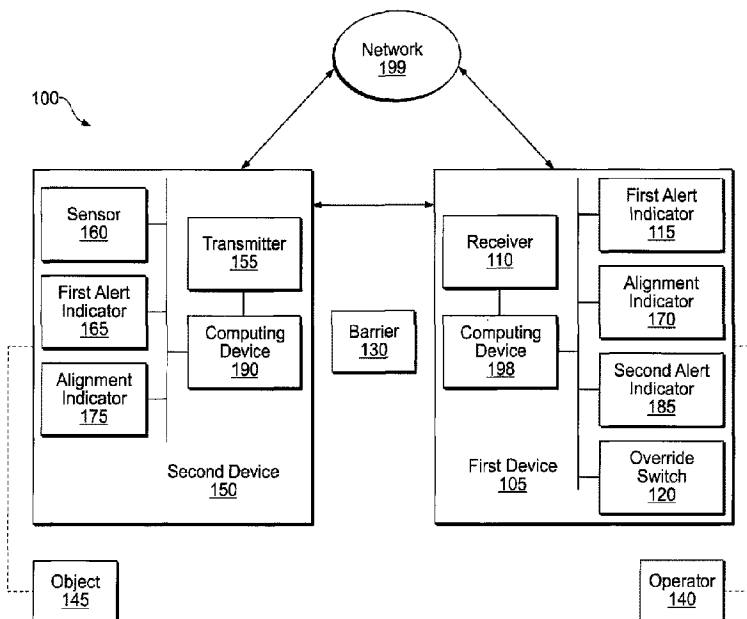
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(54) Titre : SYSTEME DE SECURITE DESTINE AUX OPERATIONS COMPORTANT UN LIEU DE TRAVAIL SUR UN COTE OPPOSE D'UNE BARRIERE PAR RAPPORT A UN DISPOSITIF

(54) Title: SAFETY SYSTEM FOR OPERATIONS HAVING A WORKING FIELD ON AN OPPOSITE SIDE OF A BARRIER FROM A DEVICE



(57) Abrégé/Abstract:

Systems and methods for increasing situational awareness for a tool operator and an individual approaching a working field of the tool are described. An example method includes activating a first device, where the first device has a working field and has an operational path configured to intersect a barrier. A proximity sensor of the second device then detects a presence of an object in a sensor zone of the second device. The second device transmits a wireless signal to the first device indicating the presence of the object in the sensor zone of the second device. Then at least one of the first device and the second device issues a first alert indicating the presence of the object in the sensor zone of the second device.

ABSTRACT

Systems and methods for increasing situational awareness for a tool operator and an individual approaching a working field of the tool are described. An example method includes activating a first device, where the first device has a working field and has an operational path configured to intersect a barrier. A proximity sensor of the second device then detects a presence of an object in a sensor zone of the second device. The second device transmits a wireless signal to the first device indicating the presence of the object in the sensor zone of the second device. Then at least one of the first device and the second device issues a first alert indicating the presence of the object in the sensor zone of the second device.

5 The disclosure generally relates to a safety system and, more particularly, to a proximity sensing and alert system and methods to deactivate a first device having an operational path configured to intersect a barrier, and to provide situational awareness to an operator of the first device and to an object near a second device arranged on an opposite side of the barrier in a non-line-of-sight position relative to the first device.

10 **BACKGROUND**

In manufacturing environments, passive indicators, such as cones, flags or signage, have been employed to alert individuals on a blind-side of an operation involving a tool with an operational path that may penetrate or pass through a barrier (e.g., airplane skin). Such passive indicators depend upon visual contact from an individual, but when an individual does not perceive the passive indicator the purpose is defeated. For example, an individual may be distracted by a cell phone, caught up in conversation, staring at the ground or stepping backwards. Subsequently, the individual may inadvertently pass into a working field into which the operational path of the tool extends.

20 In a first aspect of the disclosure, a method is described that includes activating the first device. The first device has a working field, and the first device has an operational path configured to intersect a barrier. The method further includes detecting, via a proximity sensor of a second device, a presence of an object in a sensor zone of the second device and transmitting, via the second device, a wireless signal to the first device

indicating the presence of the object in the sensor zone of the second device. The method also includes issuing a first alert, via at least one of the first device and the second device, indicating the presence of the object in the sensor zone of the second device.

In a second aspect of the disclosure, systems are also disclosed herein. One system
5 includes a first device having a receiver and at least one of a first alert indicator and an override switch. The system also includes at least one second device having a transmitter and a proximity sensor, the proximity sensor configured for communication with the transmitter of the second device, the second device configured to send at least one wireless signal to the receiver of the first device to activate one of the first alert indicator or the
10 override switch in response to the proximity sensor detecting an object within a sensor zone.

Another system includes a first device having a receiver and at least one of a first alert indicator and an override switch. This system further includes a plurality of second devices each having a proximity sensor and a transmitter that is configured for
15 communication with the proximity sensor, the plurality of second devices configured to send at least one wireless signal to the receiver of the first device to activate one of the first alert indicator or the override switch in response to at least one of the plurality of second devices detecting an object within a sensor zone of the at least one of the plurality of second devices, the plurality of second devices are configured to be arranged in a non-line-
20 of-sight position relative to the first device such that the first device and the plurality of second devices are arranged on opposite sides of a barrier.

In one embodiment, there is provided a method, involving: activating a first device, wherein the first device has a working field, wherein the first device has an operational path configured to intersect a barrier; detecting, via a proximity sensor of a second device, a presence of an object in a sensor zone of the second device; transmitting, via the second device, a wireless
5 signal to the first device indicating the presence of the object in the sensor zone of the second device; based on detecting the presence of the object in the sensor zone of the second device, issuing a first alert, via at least one of the first device and the second device, indicating the presence of the object in the sensor zone of the second device; determining, via the second device, a signal strength of the first device by measuring a power level of a pilot signal emitted
10 by the first device; displaying a signal strength indicator on at least one of the first device and the second device, wherein the displayed signal strength indicator is based on the determined signal strength; and positioning the second device relative to the first device based on the displayed signal strength indicator.

In another embodiment, there is provided a system, including: a first device having a
15 receiver and at least one of a first alert indicator and an override switch; and at least one second device having a transmitter, a proximity sensor and an alignment indicator. The proximity sensor is configured for communication with the transmitter of the second device and the second device is configured to send at least one wireless signal to the receiver of the first device to activate one of the first alert indicator or the override switch in response to the proximity sensor detecting
20 an object within a sensor zone of the second device. The alignment indicator is configured to determine a signal strength of the first device by measuring a power level of a pilot signal emitted by the first device and to display a signal strength indicator based on the determined signal strength.

In another embodiment, there is provided a system, including: a first device having a receiver and at least one of a first alert indicator and an override switch; and a plurality of second devices each having a proximity sensor and a transmitter that is configured for communication with the proximity sensor. The plurality of second devices are configured to be arranged in a non-line-of-sight position relative to the first device such that the first device and the plurality of second devices are arranged on opposite sides of a barrier. The plurality of second devices are also configured to send at least one wireless signal to the receiver of the first device to activate one of the first alert indicator or the override switch in response to at least one of the plurality of second devices detecting an object in a sensor zone of the at least one of the plurality of second devices. At least one of the plurality of second devices has an alignment indicator configured to determine a signal strength of the first device by measuring a power level of a pilot signal emitted by the first device, and to display a signal strength indicator based on the determined signal strength.

The features, functions, and advantages that have been discussed can be achieved independently in various examples or may be combined in yet other examples further details of which can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Examples are described below in conjunction with the appended drawing figures, wherein like reference numerals refer to like elements in the various figures, and wherein:

Figure 1 is a diagrammatic representation of a side view of a system, according to
5 one example implementation;

Figure 2 is a functional block diagram of the system of Figure 1, according to an example implementation;

Figure 3 is a flow diagram of a method, according to one example implementation;

Figure 4 shows a flowchart of an example method for use with the method shown
10 in Figure 3, according to an example implementation;

Figure 5 shows a flowchart of another example method for use with the method shown in Figure 3, according to an example implementation;

Figure 6 shows a flowchart of an example method for use with the method shown in Figure 3, according to an example implementation;

Figure 7 shows a flowchart of another example method for use with the method
15 shown in Figure 3, according to an example implementation;

Figure 8 shows a flowchart of an example method for use with the method shown in Figure 3, according to an example implementation;

Figure 9 shows a flowchart of another example method for use with the method
20 shown in Figure 3, according to an example implementation; and

Figure 10 is a block diagram illustrating an example of a computing device, according to an example implementation.

Corresponding parts are marked with the same reference symbols in all figures.

The drawings are provided for the purpose of illustrating examples, but it is understood that the examples are not limited to the arrangements and instrumentalities shown in the drawings.

DETAILED DESCRIPTION

5 The disclosed examples provide safety systems and methods for increasing situational awareness for a tool operator and an object approaching a working field of a first device. The systems and methods also beneficially provide the ability to alert the operator and to deactivate the tool without operator intervention, in some examples. In further examples, the systems and methods may further notify individuals that they are in
10 proximity to the working field of the device. The systems and methods also provide an advantage of being reconfigurable

 Figures 1 and 2 depict a system 100 that includes a first device 105 having a receiver 110 and at least one of a first alert indicator 115 and an override switch 120. The receiver 110 may take the form of a transceiver, as described in more detail below. The
15 first device 105 has an operational path 125 configured to intersect a barrier 130 such that a portion of the first device 105 (e.g. drill bit or saw blade) or an output (e.g., nail, laser or flame) of the first device 105 may pass through or penetrate one side 131 of the barrier 130 and enter a working field 135 of the first device 105 on an opposite side 132 of the barrier 130. In other words, the operational path 125 of the first device 105 includes the route or
20 footprint that the first device 105 and any output of the first device 105 follows during operation. As such, the working field 135 of the first device 105 includes the space into which the operational path 125 may extend from the side 132 of the barrier 130 opposite to the first device 105.

The first device **105** may include, but is not limited to a drill (shown in Figure 1), a saw, a nail gun, a sander, a blow torch, a laser and other power-cutting or portable tools. Further, the barrier **130** may be any object that creates a non-line-of-sight or blind-side operation that obstructs the view of a tool operator **140** thereby preventing observation of
5 objects **145**, including individuals, on the opposite side **132** of the barrier **130**. Example barriers **130** include, but are not limited to, an airplane skin or a wing, a ship hull or a vehicle panel in manufacturing or maintenance environments and a wall, a roof or a ceiling in a construction zone. Example barriers **130** may also include a mesh or have a plurality of openings or access ports. Other example barriers **130** may include transparent panels
10 that permit visibility but obstruct sound such that an object's auditory perception of an operation may be impaired. The barrier **130** may not create a blind-side operation *per se* and instead provides a working surface for a tool operator **140**, who may become distracted or look away from the operation of the first device **105**.

The system **100** also includes at least one second device **150** having a transmitter
15 **155** and a proximity sensor **160**. The second device **150** may also include a first alert indicator **165**, described in more detail below. The transmitter **155** may take the form of a transceiver, as described in more detail below. As shown in Figure 1, in operation, the second device **150** is arranged in a non-line-of-sight position relative to the first device **105** such that the first device **105** and the second device **150** are arranged on opposite sides
20 **131, 132** of the barrier **130**. As used herein, transceivers are devices that can both transmit and receive wireless communications, such as a combined radio transmitter and receiver that share common circuitry or a common housing. In an optional example in which the first device **105** and the second device **150** each have a transceiver, the transceiver of the

first device **105** and the transceiver of the second device **150** are capable of bi-directional wireless communication with each other.

In an alternative implementation, wireless communication (e.g. radio-based communication) between the first device **105** and the second device **150** may not be
5 feasible, for example, in areas that are shielded or where there is a significant amount of radio frequency interference. In this implementation, a wired connection between the first device **105** and the second device **150** may be utilized. The wired connection may be run through a plurality of openings or access ports, for example, in the barrier **130**. One advantage of a wired connection is that the wired connection permits power to be supplied
10 to the first device **105** and the second device **150** in place of a battery.

The proximity sensor **160** includes, but is not limited to, one or more of an optical sensor, an infrared sensor, an ultrasonic sensor, a tactile sensor, a capacitive sensor, a laser-based sensor, a through-beam sensor, a contact sensor, a camera-based sensor and a motion sensor. The proximity sensor **160** has a sensor zone **161** that has optional orientations
15 including, but not limited to, overlapping with the working field **135** of the first device **105**, establishing a perimeter surrounding the working field **135** (e.g., a light or laser curtain) or extending from the second device **150** in a direction away from the barrier **130** and the working field **135**. The proximity sensor **160** is configured for communication with the transmitter **155** of the second device **150**. In one example, the transmitter **155** of
20 the second device **150** may be part of the proximity sensor **160** and coupled together in a hard-wired, fiber-optic or electro-mechanical arrangement directly or indirectly. In an alternative, example the proximity sensor **160** and the transmitter **155** of the second device **150** may communicate wirelessly.

The second device **150** of system **100** may include a computing device **190** having one or more processors **191** to receive signals from the proximity sensor **160** and to determine whether to issue a first alert to activate one or more of the first alert indicators **115, 165** and the override switch **120**. The computing device **190** may receive signals
5 from the receiver **110** of the first device **105** to determine signal strength for alignment with the second device **150**, in one optional example. The computing device **190** is described more fully below with reference to Figure **10**. In alternative implementations, analog electrical components, integrated circuits or microprocessors may be utilized to perform the same functions of the computing device **190**. The computing device **190** is
10 communicatively coupled to the proximity sensor **160**, the receiver **110**, the transmitter **155**, the first alert indicators **115, 165**, the override switch **120**, the alignment indicators **170, 175** and the second alert indicator **185**. In one example, the computing device **190** is directly wired to components of the second device **150**, including the transmitter **155**, proximity sensor **160**, the first alert indicator **165** of the second device **150** and alignment
15 indicator **175** and is wirelessly connected to components of the first device **105**, including the receiver **110**, the first alert indicator **115**, the override switch **120**, the alignment indicator **170** and the second alert indicator **185**. In another example, the computing device **190** is wirelessly connected to the proximity sensor **160**, the receiver **110**, the transmitter **155**, the first alert indicators **115, 165**, the override switch **120**, the alignment
20 indicators **170, 175** and the second alert indicator **185**.

The second device **150** is configured to send at least one wireless signal to the receiver **110** of the first device **105** to activate one of the first alert indicator **115** or the override switch **120** in response to the proximity sensor **160** detecting an object **145** within

a working field **135** of the first device **105**. The object **145** includes, but is not limited to, individuals, vehicles or other equipment. In one optional example, shown in Figure 1, the second device **150** also includes a first alert indicator **165** arranged to alert an object **145** detected by the proximity sensor **160** that the object **145** has entered the sensor zone **161** of the second device **150**. In examples, the computing device **190** has one or more processors **191**, as shown in Figure 10, to determine whether to issue a first alert to activate one or more of the first alert indicators **115**, **165** and the override switch **120** based on a signal received from the proximity sensor **160** indicating that an object **145** has been detected. The computing device **190** may output the first alert to one or both of the first alert indicators **115**, **165** and/or the override switch **120**. In order to reduce or avoid injury or damage to the object **145**, the first alert indicator **115** is configured to alert an operator **140** of the first device **105** of a detected object **145** and the override switch **120** is configured to stop at least one mode of operation of the first device **105** or to deactivate operation of the first device **105** altogether. For example, the first alert indicator **115** of the first device **105** may be a device that provides visual, audible, or tactile feedback. In various examples, the first alert indicator **115** of the first device **105** includes, but is not limited to, at least one of a light (shown in Figure 1), an electronic display, an alarm and a vibration controller. In a further optional example, the first alert indicator **115** is a work light **116** (shown in Figure 1) coupled to the first device **105** that is configured to pulse in response to a signal received from the second device **150**. The first alert indicator **165** of the second device **150** may also provide visual, audible, or tactile feedback in the form of at least one of a light, an electronic display, an alarm and a vibration controller.

In one example in which the first device **105** is an electrically-powered tool, the override switch **120** includes software code containing instructions executable by computing device **198** to control hardware in the form of a circuit breaker, relay or electrically operated switch, for example, that is coupled directly to circuitry for an electric motor of the first device **105** through a system of wires. When the override switch **120** is closed, the electricity is permitted to flow freely through the circuit. When the override switch **120** receives a signal from the second device **150** via the receiver **110** from the first device **105**, the override switch **120** is responsively opened thereby interrupting the flow of electricity to the motor. Such an arrangement permits the electrically-powered tool to respond in real-time to the actuation of the override switch **120**. In another optional example, the override switch **120** may correspond to software configured to execute code to cause the first device **105** to stop operation or operate in a different mode. The software instructions may reside on a server accessible via a network **199** or stored locally on computing device **198**. In an alternative example in which the first device **105** is powered pneumatically, the override switch **120** is coupled to one of a pneumatic switch box or in-line with an air hose coupled to the first device **105**. In the foregoing example, the override switch **120** takes the form of an air pressure release valve. Under normal operation, the air pressure release valve is closed thereby maintaining air pressurization in the pneumatic system. In response to a signal from the second device **150** received via the receiver **110** from the first device **105**, the air pressure release valve opens thus releasing air in the hose to both stop driving the motor of the first device and alleviate stored potential energy from pressurized air in the pneumatic system.

Optionally, at least one of the first device **105** and the second device **150** has an alignment indicator **170, 175** configured to indicate a signal strength of the first device **105** relative to the second device **150**. In operation, the first device **105** continuously emits a pilot signal via the receiver **110**. As used herein, a pilot signal is a single frequency signal transmitted over a communications system for location purposes. The second device **150** receives the pilot signal and the computing device **190** constantly determines the strength of the pilot signal by measuring the power level of the pilot signal. As the distance between the first device **105** and the second device **150** increases, the signal strength of the pilot signal from the first device **105** decreases and vice versa. The computing device **190** also constantly compares the determined signal strength to a plurality of signal strength thresholds to adjust the alignment indicator **170, 175**. Since the materials and thicknesses of barrier **130** may vary, an initial calibration step may be performed to set a base line value for each of the plurality of signal strength thresholds. Alternatively, the computing device may query a material setting or perform a location lookup from a prior use of the second device **150** in the same area. The specific values of the signal strength thresholds are application dependent and are based on factors that include, but are not limited to, the size of the working field **135** and/or the size of the operational path **125** of the first device **105** and the thickness of the barrier **130**.

The alignment indicators **170, 175** assist an operator **140** with placement of the second device **150** relative to first device **105**, since the barrier **130** may impair placement of the second device **150** based on visual cues alone. In one example, the alignment indicators **170, 175** include a plurality of LEDs that turn on in succession as signal strength of the first device **105** received by the second device **150** increases and exceeds one or

more signal strength thresholds and that turn off in succession as the signal strength decreases and falls below one or more signal strength thresholds. In another example, the alignment indicators **170, 175** are a multicolored LED that displays as red when a signal strength of the first device **105** received by the second device **150** is below a low signal strength threshold, displays as yellow when the signal strength is above the low signal strength threshold and below a high signal strength threshold and displays as green when the signal strength is above the high signal strength threshold. In yet a further example, the alignment indicators **170, 175** are a light that blinks at different rates based on the signal strength of the first device **105** received by the second device **150**, such that the light blinks faster as the signal strength increases and exceeds one or more signal strength thresholds. In alternative examples, the alignment indicators **170, 175** may include an electronic display or auditory feedback.

The computing device **190** contains hardware and software that are configured to automatically move the second device **150** in response to a determination by the computing device **190** that a signal received from the first device has a signal strength that is lower than a predetermined signal strength threshold. As described above, the first device **105** continuously emits a pilot signal via the receiver **110**. The second device **150** receives the pilot signal and the computing device **190** constantly determines the strength of the pilot signal by measuring the power level of the pilot signal. As the distance between the first device **105** and the second device **150** increases, the signal strength of the pilot signal from the first device **105** decreases and vice versa. The computing device **190** also constantly compares the determined signal strength of the first device **105** to the predetermined signal strength threshold to determine whether to execute instructions causing the second device

150 to relocate. The specific value of the predetermined signal strength threshold is application dependent and based on factors that include, but are not limited to, the size of the working field **135** and/or the size of the operational path **125** of the first device **105** and the thickness of the barrier **130**. In one example, the predetermined threshold is set based upon a signal strength of the first device **105** that indicates a desired proximity of the working field **135** of the first device **105** to the second device **150**. As one illustration, when an operator **140** moves the first device **105** to another section of the barrier **130** such that the working field **135** of the first device **105** is not aligned with the proximity sensor **160** of the second device **150**, then the second device **150** will detect this movement based on a decreased signal strength from the first device **105** that is less than the predetermined signal strength threshold. The computing device **190** may then execute instructions causing an electric motor of the second device **150** to activate and drive wheels, rollers or other ambulatory mechanisms coupled to the second device such that the second device **150** moves to a new position along the barrier **130** to realign with the first device **105**. And once the second device **150** determines the signal strength from the first device **105** that exceeds the predetermined signal strength threshold, the computing device **190** may execute instructions causing the electric motor of the second device **150** to deactivate such that movement stops. In a further optional example, the second device **150** is configured to move along a guide-rail or a track **180** disposed along the length of the barrier **130** to facilitate alignment of the second device **150** relative to the first device **105**.

In one optional example, the first device **105** has a computing device **198** that has the same form and attributes as that of computing device **190** described with respect to Figure **10** below. The computing device **198** is communicatively coupled to the receiver

110, the first alert indicator **115**, the override switch **120**, the alignment indicators **170** and the second alert indicator **185**. The computing device **198** is directly wired to components of the first device **105**, including the receiver **110**, the first alert indicator **115**, the override switch **120**, the alignment indicator **170** and the second alert indicator **185**. In another
5 example, the computing device **198** is wirelessly connected to the receiver **110**, the first alert indicator **115**, the override switch **120**, the alignment indicator **170** and the second alert indicator **185**.

Optionally, a second alert indicator **185** is coupled to the first device **105** and configured to activate in response to a determination that a signal of the second device **150**
10 failed to be detected for a predetermined amount of time. In operation, the computing device **198** receives signals from the transmitter **155** of the second device **150** to determine signal strength for detection of the second device **150**. The second device **150** continuously emits a pilot signal via the transmitter **155**. The first device **105** receives the pilot signal and the computing device **198** constantly determines the strength of the pilot
15 signal by measuring the power level of the pilot signal from the second device **150** and determines whether the signal strength has a non-zero value. If the measured signal strength is determined to have a zero value, this constitutes a failure to detect a signal of the second device **150**. A failure to detect a signal from the second device **150** may be an indication of a dead battery in the second device **150** or that the second device **150** was
20 inadvertently moved away from the working field **135** of the first device **105**. In an alternative example, the first alert indicator **115** of the first device **105** could be configured to issue one type of alert in response to the second device **150** detecting an object **145** and

to issue a second type of alert in response to a failure to detect a signal from the second device **150** after a predetermined amount of time (e.g., a watchdog timer).

Optionally, the system **100** includes a plurality of second devices **150**, like those shown in Figures **1-2**, each having a proximity sensor **160** and a transmitter **155** that is
5 configured for communication with the proximity sensor **160**. The plurality of second devices **150** are configured to send at least one wireless signal to the transmitter **155** of the first device **105** to activate one of the first alert indicator **115** or the override switch **120** in response to at least one of the plurality of second devices **150** detecting the object **145** within in the sensor zone **161** of the at least one of the plurality of second devices **150**.
10 The plurality of second devices **150** are further configured to be arranged in a non-line-of-sight position relative to the first device **105** such that the first device **105** and the plurality of second devices **150** are arranged on opposite sides of the barrier **130**. For example, the plurality of second devices **150** may be arranged along the length or perimeter of the barrier **130** in a spaced apart manner. This example has the advantage of permitting an
15 operator **140** of the first device **105** to move along the length of the barrier **130** without moving or realigning a single second device **150** with the working field **135** of the first device **105**.

In other optional examples, the system **100** further includes a plurality of first devices **105**, like those shown in Figures **1-2**, each having a receiver **110** and at least one of
20 a first alert indicator **115** and an override switch **120**. Each of the plurality of first devices **105** may be in communication with one or more second devices **105** to permit multiple operators **140** to work on the barrier **130**.

Figure **3** shows a flowchart of an example method **200** for increasing situational

awareness for an operator **140** and an object **145** approaching a working field **135** of a first device **105**, according to an example implementation. Method **200** shown in Figure **3** presents an example of a method that could be used with the system **100**, for example. Further, devices or systems may be used or configured to perform logical functions presented in Figure **3**. In some instances, components of the devices and/or systems may be configured to perform the functions such that the components are actually configured and structured (with hardware and/or software) to enable such performance. In other examples, components of the devices and/or systems may be arranged to be adapted to, capable of, or suited for performing the functions, such as when operated in a specific manner. Method **200** may include one or more operations, functions, or actions as illustrated by one or more of blocks **205-285**. Although the blocks are illustrated in a sequential order, these blocks may also be performed in parallel, and/or in a different order than those described herein. Also, the various blocks may be combined into fewer blocks, divided into additional blocks, and/or removed based upon the desired implementation.

It should be understood that for this and other processes and methods disclosed herein, flowcharts show functionality and operation of one possible implementation of the present examples. In this regard, each block may represent a module, a segment, or a portion of program code, which includes one or more instructions executable by a processor for implementing specific logical functions or steps in the process. The program code may be stored on any type of computer readable medium or data storage, for example, such as a storage device including a disk or hard drive. Further, the program code can be encoded on a computer-readable storage media in a machine-readable format, or on other non-transitory media or articles of manufacture. The computer readable medium may

include non-transitory computer readable medium or memory, for example, such as computer-readable media that stores data for short periods of time like register memory, processor cache and Random Access Memory (RAM). The computer readable medium may also include non-transitory media, such as secondary or persistent long term storage, like read only memory (ROM), optical or magnetic disks, compact-disc read only memory (CD-ROM), for example. The computer readable media may also be any other volatile or non-volatile storage systems. The computer readable medium may be considered a tangible computer readable storage medium, for example.

In addition, each block in Figure 3, and within other processes and methods disclosed herein, may represent circuitry that is wired to perform the specific logical functions in the process. Alternative implementations are included within the scope of the examples of the present disclosure in which functions may be executed out of order from that shown or discussed, including substantially concurrent or in reverse order, depending on the functionality involved, as would be understood by those reasonably skilled in the art.

Referring now to Figure 3, a method 200 is illustrated using the system of Figures 1-2. Method 200 includes, at block 205, activating the first device 105, where the first device 105 has a working field 135 and has an operational path 125 configured to intersect a barrier 130. At block 210, the second device 150 detects, via a proximity sensor 160 of the second device 150, a presence of an object 145 in a sensor zone 161 of the second device 150. Then, at block 215, a wireless signal is transmitted, via the second device 150, to the first device 105 indicating the presence of the object 145 in the sensor zone 161 of the second device 150. And, at block 220, a first alert is issued, via at least one of the first

device **105** and the second device **150**, that indicates the presence of the object **145** in the sensor zone **161** of the second device **150**. In an optional example, the second device **150** may receive a wireless signal from the first device **105** upon activation of the first device **105** as an initializing step. Performing an initialization step may permit the second device
5 **150** to power the sensor **160** when the first device **105** is active and thereby conserve battery life of the second device **150**.

In one example, issuing the first alert includes at least one of activating a feedback mode of either the first device **105** or second device **150** or disabling at least one operative function of the first device **105**. In a further example, the feedback mode may include
10 issuing a visual alert, an audible alert, or a tactile alert. In operation, when an object **145** is detected in the sensor zone **161**, activating a feedback mode of the first device **105** or second device **150** may help avoid contact between the object **145** and the first device **105**. In another optional example, detecting, via the proximity sensor **160** of the second device **150**, the presence of the object **145** in the sensor zone **161** of the second device **150**
15 includes detecting the presence of the object **145** in the working field **135** of the first device **105**, and issuing the first alert includes disabling at least one operative function of the first device **105**. In operation, once an object **145** is detected in the working field **135** of the first device **105** activating a feedback mode of the first device **105** and the second device **150** may not provide enough advance warning to an operator **140** or object **145** to
20 avoid contact between the first device **105** and the object **145**. Thus, disabling an operative function of the first device **105**, such as drilling, sawing or emission of a laser or flame, may further reduce any injury or damage to the object **145** and help avoid contact between the first device **105** and the object **145**.

In one example, shown in Figure 4 at block 225, method 200 includes arranging the second device 150 in a non-line-of-sight position relative to the first device 105 such that the first device 105 and the second device 150 are arranged on opposite sides 131, 132 of the barrier 130. This arrangement permits increased situational awareness for one or both of an operator 140 of the first device 105 and an object 145 detected by the second device 150.

In one optional example, shown in Figure 5, method 200 includes, at block 230, determining, via the second device 150, a signal strength of the first device 105. In operation, the receiver 110 of the first device 105 is a transceiver that continuously emits a pilot signal. The transmitter 155 of the second device 150 is a transceiver that receives the pilot signal and the computing device 190 constantly determines the strength of the pilot signal by measuring the power level of the pilot signal. The computing device 190 also constantly compares the determined signal strength to a plurality of signal strength thresholds to adjust the alignment indicator 170, 175. The specific values of the signal strength thresholds are application dependent and are based on factors that include, but are not limited to, the size of the working field 135 and/or the size of the operational path 125 of the first device 105 and the thickness of the barrier 130. Next, at block 235, a signal strength indicator is displayed on at least one of the first device 105 and the second device 150. The displayed signal strength indicator is based on the determined signal strength and the comparison to the plurality of signal strength thresholds. In some examples, the signal strength indicator has the form of the alignment indicator 170 discussed above with respect to system 100. And then, at block 240, the second device 150 is positioned relative to the first device 105 based on the displayed signal strength indicator. Accordingly, the signal

strength indicator improves the alignment of the second device **150** with the first device **105**, when, for example, the second device **150** is arranged in a non-line-of-sight position relative to the first device **105**.

For another optional example, shown in Figure 6, method **200** includes, at block
5 **245**, moving the first device **105** to a location remote from the second device **150**. Then, at block **250**, the second device **150** determines that a signal strength of the first device **105** is less than a predetermined signal strength threshold. As described above, the receiver **110** of the first device **105** is a transceiver that continuously emits a pilot signal. The transmitter **155** of the second device **150** is a transceiver that receives the pilot signal and
10 the computing device **190** constantly determines the strength of the pilot signal by measuring the power level of the pilot signal. As the distance between the first device **105** and the second device **150** increases, the signal strength of the pilot signal from the first device **105** decreases and vice versa. The computing device **190** also constantly compares the determined signal strength of the first device **105** to the predetermined signal strength
15 threshold to determine whether to execute instructions causing the second device **150** to relocate. The specific value of the predetermined signal strength threshold is application dependent and based on factors that include, but are not limited to, the size of the working field **135** and/or the size of the operational path **125** of the first device **105** and the thickness of the barrier **130**. And at block **255**, in response to determining the signal
20 strength of the first device **105** is less than the predetermined signal strength threshold, moving the second device **150** in a direction of the first device **105**. For example, in one implementation, a plurality of sensors capable of detecting signal strength may be placed in a spaced apart arrangement along a predetermined direction of travel. In an alternative

example implementation, small advancements of the proximity sensor platform are made and the signal strength of the first device **105** is monitored during the advancements to determine the location of the first device **105** and to determine the direction of motion to relocate the second device **150**. As discussed above with respect to system **100**, when an
5 operator **140** moves the first device **105** to another section of the barrier **130** such that the working field **135** of the first device **105** is outside the range of the proximity sensor **160** of the second device **150**, then the second device **150** will detect this movement based on a decreased signal strength from the first device **105** that is less than the predetermined signal strength threshold. For example, the computing device **190** may execute
10 instructions causing an electric motor of the second device **150** to activate and drive wheels, rollers or other ambulatory mechanisms coupled to the second device such that movement is effected. In a further optional example, moving the second device **150** in the direction of the first device **105** includes the second device **150** automatically moving along a guide-rail or a track **180** in response to sensor feedback detecting motion of the
15 first device **105**. In this example, the second device **150** may include additional proximity sensors that have sensor zones arranged facing potential directions of movement of the second device **150** to avoid contact with an object **145**. In yet another optional example, shown in Figure 7, the method **200** includes, at block **260**, determining, via the second device **150**, the signal strength of the first device **105**. Then, at block **265**, the second
20 device **150** determines that the signal strength of the first device **105** meets the predetermined signal strength threshold and, at block **270**, in response to determining the signal strength of the first device **105** meets or exceeds the predetermined signal strength threshold, movement of the second device **150** ceases. For example, the computing device

190 may execute instructions causing an electric motor of the second device 150 to deactivate such that movement stops. The operations, functions, or actions as illustrated by blocks 245-270 permit automatic movement of the second device 150 without intervention by the operator 140 of the first device 105.

5 In one optional example, shown in Figure 8, method 200 includes, at block 275, determining that a signal strength of the second device 150 failed to be detected by the first device 105 for a predetermined amount of time. In this example, the first device 105 has a computing device 198 that has the same form and attributes as that of computing device 190 described with respect to Figure 10 below. The computing device 198 receives signals
10 from the transmitter 155 of the second device 150 to determine signal strength for detection of the second device 150. In this example, the second device 150 continuously emits a pilot signal via the transmitter 155. The first device 105 receives the pilot signal and the computing device 198 constantly determines the strength of the pilot signal by measuring the power level of the pilot signal from the second device 150 and determines
15 whether the signal strength has a non-zero value. If the measured signal strength is determined to have a zero value for a predetermined amount of time, this constitutes a failure to detect a signal of the second device 150. And, at block 280, a second alert is issued via the first device 105. In operation, a failure to detect a signal from the second device 150 may be an indication of a dead battery in the second device 150 or that the
20 second device 150 was inadvertently moved away from the working field 135 of the first device 105. The second alert may take any of the forms and have any of the effects of the first alert discussed in detail above.

In another optional example, shown in Figure 9, method 200 includes, at block 285, in response to detecting, via the proximity sensor 160 of the second device 150, the presence of the object 145 in the sensor zone 161 of the second device 150, recording via a computing device 190 of the second device 150 or a network 199 at least one sensor-signal event. The sensor-signal event information may include, but is not limited to, a time-stamp, an identification of the specific proximity sensor 160 that detected the object 145 and a location of the proximity sensor 160 at the time of detection. In another example, the sensor-signal event information may further include an indication as to whether the object 145 was detected in the working field 135 of the first device 105.

Figure 10 is a block diagram illustrating an example of the computing device 190, according to an example implementation. The computing device 190 may be used to perform functions of methods shown in Figures 3-9. The computing device 190 has a processor(s) 191, and also a communication interface 192, data storage 193, an output interface 194, and a display 195 each connected to a communication bus 196. The computing device 190 may also include hardware to enable communication within the computing device 190 and between the computing device 190 and other devices (not shown). The hardware may include transmitters, receivers, and antennas, for example.

The communication interface 192 may be a wireless interface and/or one or more wired interfaces that allow for both short-range communication and long-range communication to one or more networks 199 or to one or more remote devices. Such wireless interfaces may provide for communication under one or more wireless communication protocols, such as Bluetooth™, WiFi™ (e.g., an institute of electrical and electronic engineers (IEEE) 802.11 protocol), Long-Term Evolution (LTE), cellular

communications, near-field communication (NFC), and/or other wireless communication protocols. Such wired interfaces may include Ethernet interface, a Universal Serial Bus (USB) interface, or similar interface to communicate via a wire, a twisted pair of wires, a coaxial cable, an optical link, a fiber-optic link, or other physical connection to a network

5 **199.** Thus, the communication interface **192** may be configured to receive input data from one or more devices, and may also be configured to send output data to other devices.

The communication interface **192** may also include a user-input device, such as a keyboard or mouse, for example.

The data storage **193** may include or take the form of one or more computer-

10 readable storage media that can be read or accessed by the processor(s) **191**. The computer-readable storage media can include volatile and/or non-volatile storage components, such as optical, magnetic, organic or other memory or disc storage, which can be integrated in whole or in part with the processor(s) **191**. The data storage **193** is considered non-transitory computer readable media. In some examples, the data storage

15 **193** can be implemented using a single physical device (e.g., one optical, magnetic, organic or other memory or disc storage unit), while in other examples, the data storage **193** can be implemented using two or more physical devices.

The data storage **193** thus is a non-transitory computer readable storage medium, and executable instructions **197** are stored thereon. The instructions **197** include computer

20 executable code. When the instructions **197** are executed by the processor(s) **191**, the processor(s) **191** are caused to perform functions. Such functions include receiving signals from the proximity sensor **160** and determining whether to issue a first alert to activate one or more of the first alert indicators **115**, **165** and the override switch **120**, as well as

receiving signals from the receiver 110 of the first device 105 and determining signal strength of the first device 105 for alignment with the second device 150.

The processor(s) 191 may be a general-purpose processor or a special purpose processor (e.g., digital signal processors, application specific integrated circuits, etc.). The processor(s) 191 may receive inputs from the communication interface 192, and process the inputs to generate outputs that are stored in the data storage 193 and output to the display 195. The processor(s) 191 can be configured to execute the executable instructions 197 (e.g., computer-readable program instructions) that are stored in the data storage 193 and are executable to provide the functionality of the computing device 190 described herein.

The output interface 194 outputs information to the display 195 or to other components as well. Thus, the output interface 194 may be similar to the communication interface 192 and can be a wireless interface (e.g., transmitter) or a wired interface as well. The output interface 194 may send information about detection of an object 145 to the first alert indicators 115, 165 and/or to the override switch 120, for example, and send information about signal strength of the first device 105 to the alignment indicator 175 of the second device 150, for example.

The computing device 190 shown in Figure 10 may also be representative of the computing device 198, for example.

The description of the different advantageous arrangements has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the examples in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. Further, different advantageous examples may describe

different advantages as compared to other advantageous examples. The example or examples selected are chosen and described in order to best explain the principles of the examples, the practical application, and to enable others of ordinary skill in the art to understand the disclosure for various examples with various modifications as are suited to

5 the particular use contemplated.

EMBODIMENTS IN WHICH AND EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method, comprising:

activating a first device, wherein the first device has a working field, wherein
5 the first device has an operational path configured to intersect a barrier;

detecting, via a proximity sensor of a second device, a presence of an object in
a sensor zone of the second device;

transmitting, via the second device, a wireless signal to the first device
indicating the presence of the object in the sensor zone of the second device;

10 based on detecting the presence of the object in the sensor zone of the second
device, issuing a first alert, via at least one of the first device and the second
device, indicating the presence of the object in the sensor zone of the second
device;

determining, via the second device, a signal strength of the first device by
15 measuring a power level of a pilot signal emitted by the first device;

displaying a signal strength indicator on at least one of the first device and the
second device, wherein the displayed signal strength indicator is based on the
determined signal strength; and

20 positioning the second device relative to the first device based on the displayed
signal strength indicator.

**2. The method of claim 1, wherein detecting, via the proximity sensor of the second
device, the presence of the object in the sensor zone of the second device comprises
detecting the presence of the object in the working field of the first device, and wherein**

issuing the first alert comprises disabling at least one operative function of the first device.

3. The method of claim 1 or 2, further comprising:

5 arranging the second device in a non-line-of-sight position relative to the first device such that the first device and the second device are arranged on opposite sides of the barrier.

4. The method of any one of claims 1-3, further comprising:

moving the first device to a location remote from the second device;

10 determining, via the second device, that the signal strength of the first device is less than a predetermined signal strength threshold; and

in response to determining the signal strength of the first device is less than the predetermined signal strength threshold, moving the second device in a direction of the first device.

15 5. The method of claim 4, wherein moving the second device in the direction of the first device comprises the second device automatically moving along a guide-rail or a track in response to sensor feedback.

6. The method of claim 4 or 5, further comprising:

determining, via the second device, the signal strength of the first device meets or exceeds the predetermined signal strength threshold; and

20 in response to determining the signal strength of the first device meets or exceeds the predetermined signal strength threshold, ceasing movement of the second device.

7. The method of any one of claims 1-6, further comprising

determining that a signal strength of the second device failed to be detected by the first device for a predetermined amount of time; and

issuing a second alert via the first device.

- 5 8. The method of any one of claims 1-7, wherein issuing the first alert comprises issuing a visual alert, an audible alert, or a tactile alert.
9. The method of claim 1, wherein issuing the first alert comprises at least one of activating a feedback mode of either the first device or the second device or disabling at least one operative function of the first device.
10. The method of any one of claims 1-9, further comprising:
10 in response to detecting, via the proximity sensor of the second device, the presence of the object in the sensor zone of the second device, recording via a computing device of the second device or a network at least one sensor-signal event.
11. The method of claim 10, wherein recording the at least one sensor-signal event
15 comprises recording information including a time-stamp, an identification of the proximity sensor that detected the object, and a location of the proximity sensor at a time of detection.
12. The method of claim 10 or 11, wherein recording the at least one sensor-signal event
20 comprises recording information including an indication as to whether the object was detected in the working field of the first device.
13. The method of any one of claims 1-12, wherein activating the first device comprises activating an electrically-powered tool.
14. The method of claim 1 or 2, wherein the second device is one of a plurality of second devices arranged in a non-line-of-sight position relative to the first device such that the

first device and the plurality of second devices are arranged on opposite sides of the barrier, and the method further comprising:

detecting, via multiple of the plurality of second devices, presences of the object in respective sensor zones of the plurality of second devices; and

5 transmitting, via the multiple of the plurality of second devices, wireless signals to the first device to activate one of a first alert indicator of the first device or an override switch of the first device.

15. The method of any one of claims 1-13, further comprising sending, via the second device, a signal to the first device to activate an override switch of the first device in
10 response to the proximity sensor detecting the presence of the object within the sensor zone of the second device.

16. The method of claim 15, further comprising activating the override switch and stopping at least one mode of operation of the first device based on receipt of the signal.

17. The method of claim 15 or 16, further comprising activating the override switch and
15 the first device responding in real-time to activation of the override switch.

18. A system, comprising:

a first device having a receiver and at least one of a first alert indicator and an override switch; and

20 at least one second device having a transmitter, a proximity sensor and an alignment indicator, the proximity sensor configured for communication with the transmitter of the second device, the second device configured to send at least one wireless signal to the receiver of the first device to activate one of the first alert indicator or the override switch in response to the proximity sensor detecting an object within a sensor zone of the second device, and the alignment
25 indicator configured to determine a signal strength of the first device by

measuring a power level of a pilot signal emitted by the first device and to display a signal strength indicator based on the determined signal strength.

- 5 **19.** The system of claim **18**, wherein the second device is arranged in a non-line-of-sight position relative to the first device such that the first device and the second device are arranged on opposite sides of a barrier.
- 20.** The system of claim **18** or **19**, wherein the alignment indicator comprises at least one of a plurality of LEDs, a multicolored LED and a light that blinks at different rates based on the signal strength of the first device.
- 10 **21.** The system of any one of claims **18-20**, wherein the proximity sensor comprises at least one of an optical sensor, an infrared sensor, an ultrasonic sensor, a tactile sensor, a contact sensor, a capacitive sensor, a laser-based sensor, a through-beam sensor, a camera-based sensor and a motion sensor.
- 22.** The system of any one of claims **18-21**, wherein the first alert indicator comprises a controller configured to cause at least one of visual, audible, or tactile feedback.
- 15 **23.** The system of any one of claims **18-22**, wherein the second device further comprises a computing device configured to automatically move the second device in response to a determination by the computing device that the signal strength of the first device is lower than a predetermined signal strength threshold.
- 24.** The system of any one of claims **18-23**, further comprising:
- 20 a second alert indicator coupled to the first device and configured to activate in response to a determination that a signal strength of the second device failed to be detected for a predetermined amount of time.

25. A system, comprising:

a first device having a receiver and at least one of a first alert indicator and an override switch; and

5 a plurality of second devices each having a proximity sensor and a transmitter that is configured for communication with the proximity sensor, the plurality of second devices are configured to be arranged in a non-line-of-sight position relative to the first device such that the first device and the plurality of second devices are arranged on opposite sides of a barrier,

10 wherein the plurality of second devices are configured to send at least one wireless signal to the receiver of the first device to activate one of the first alert indicator or the override switch in response to at least one of the plurality of second devices detecting an object in a sensor zone of the at least one of the plurality of second devices, and

15 wherein at least one of the plurality of second devices has an alignment indicator configured to determine a signal strength of the first device by measuring a power level of a pilot signal emitted by the first device, and to display a signal strength indicator based on the determined signal strength.

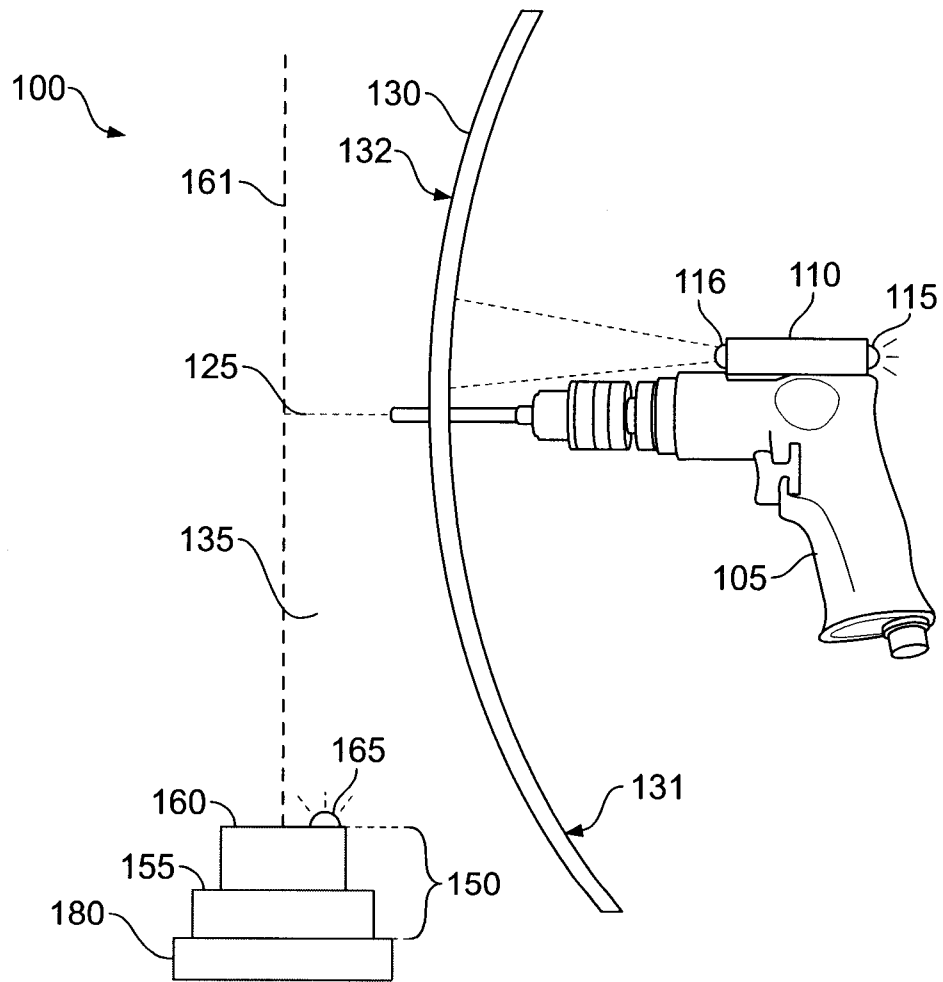


FIG. 1

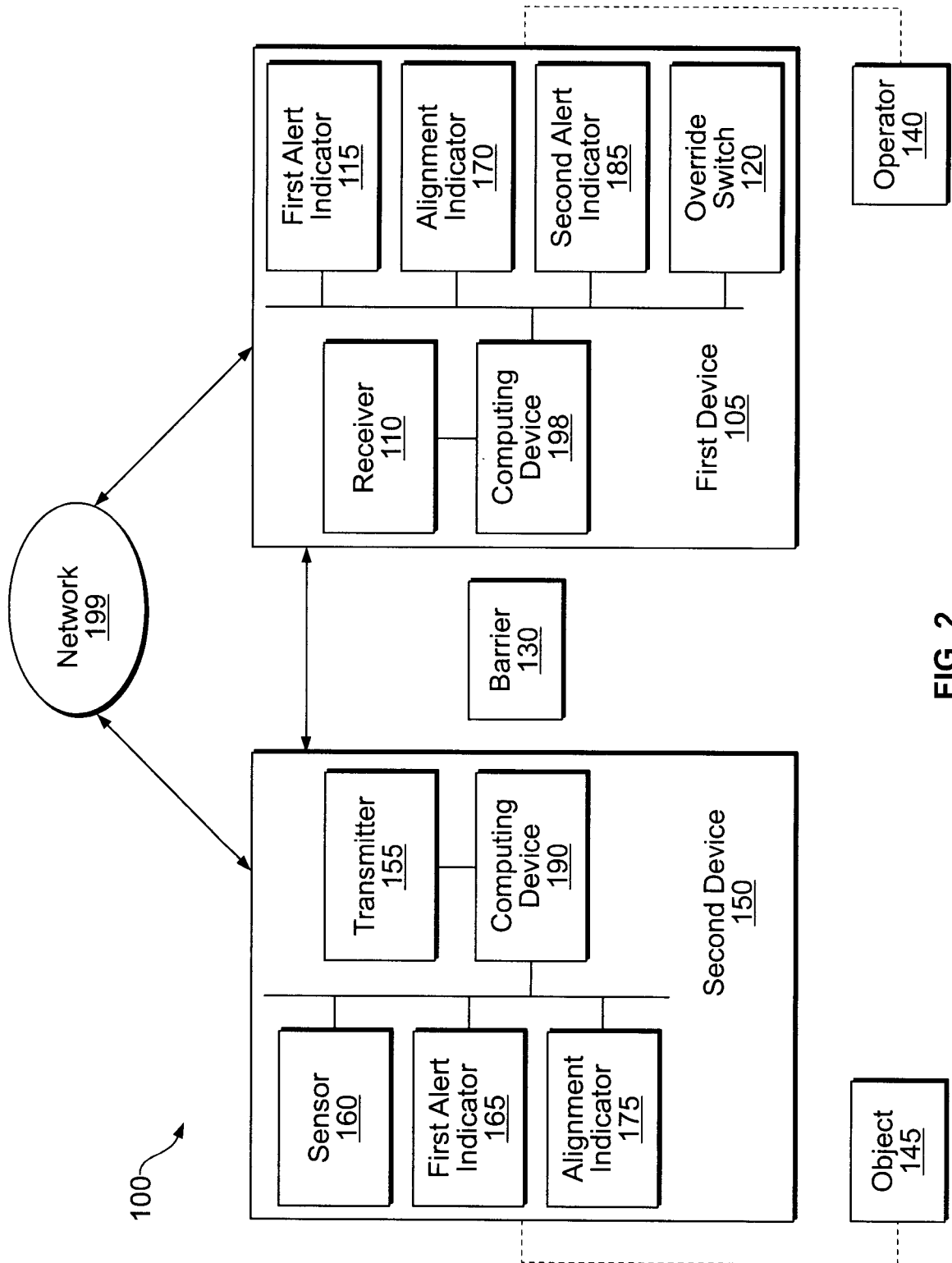


FIG. 2

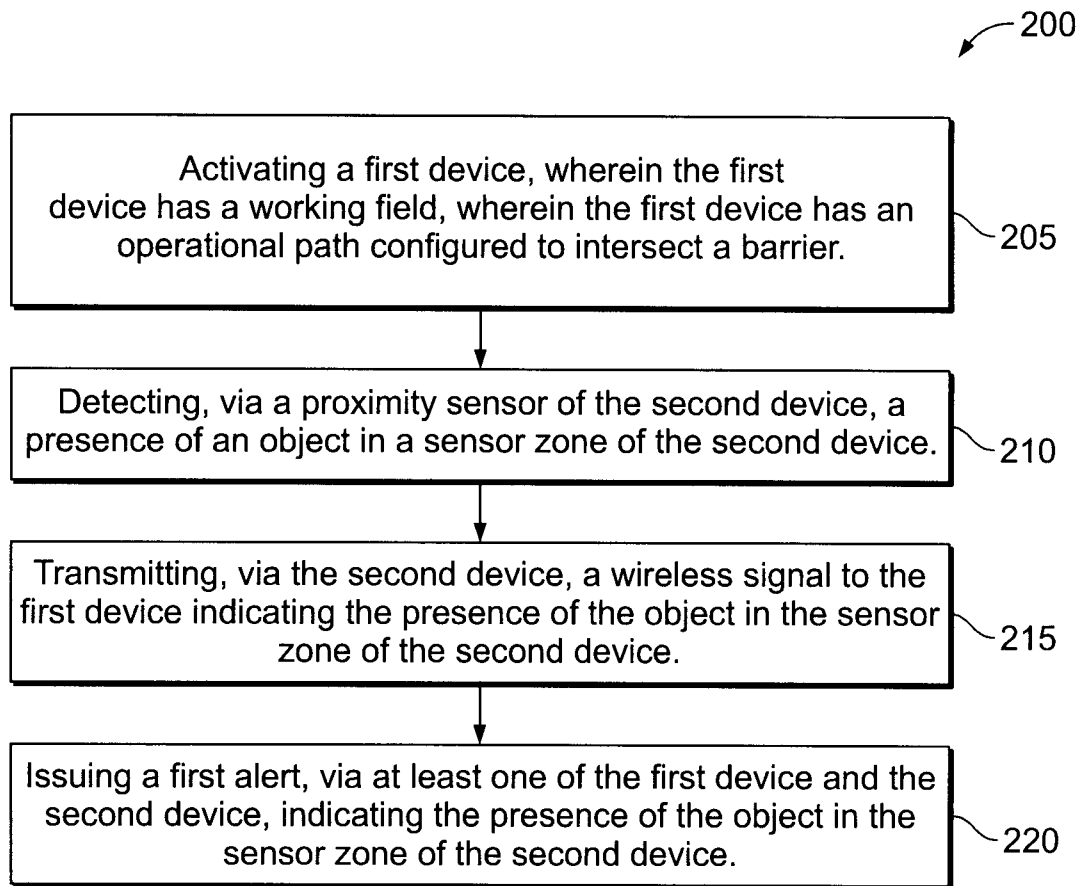


FIG. 3

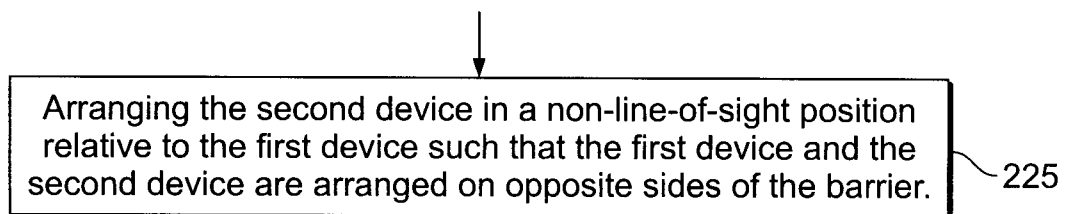


FIG. 4

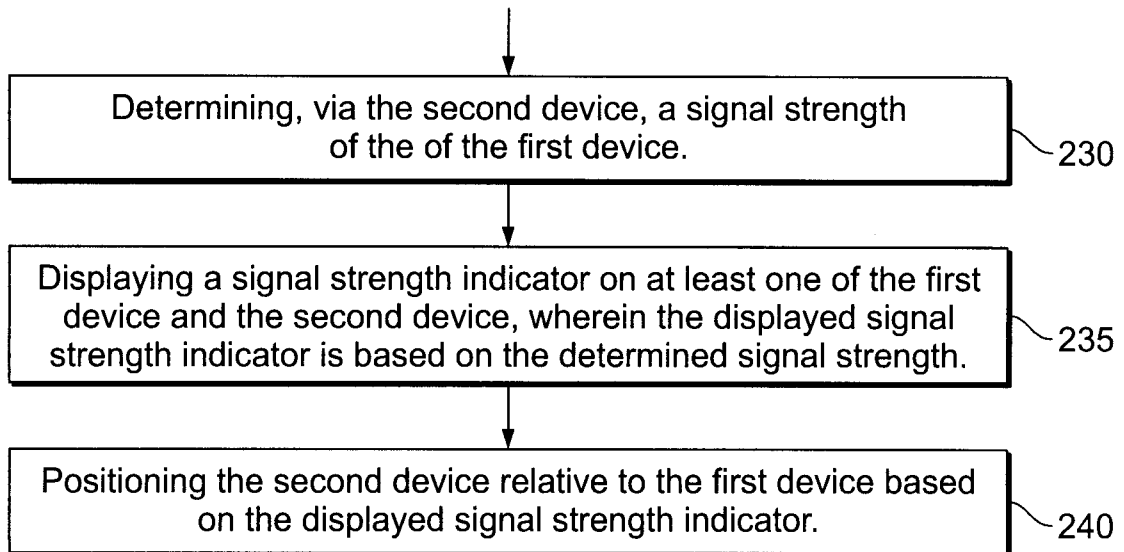


FIG. 5

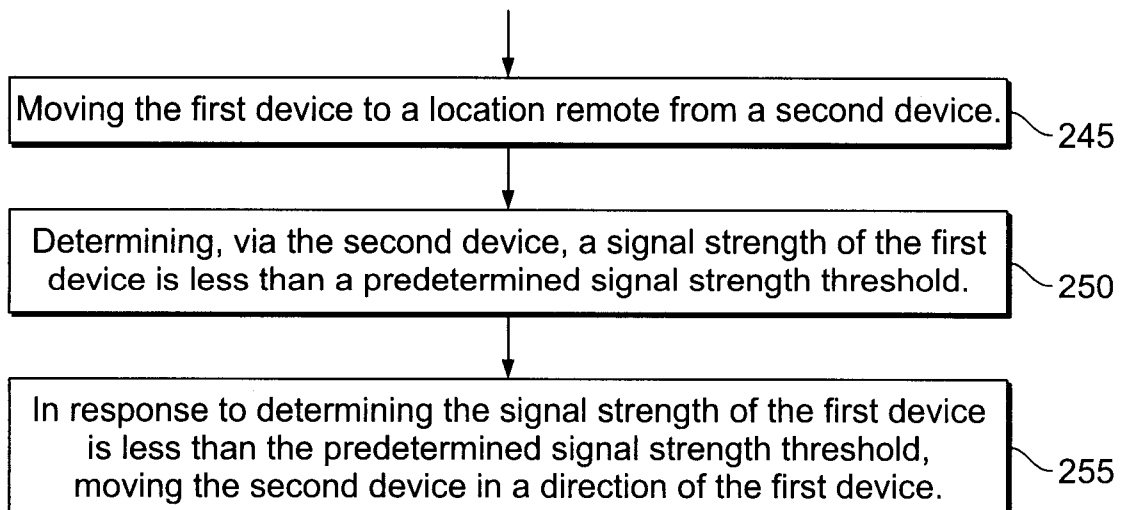


FIG. 6

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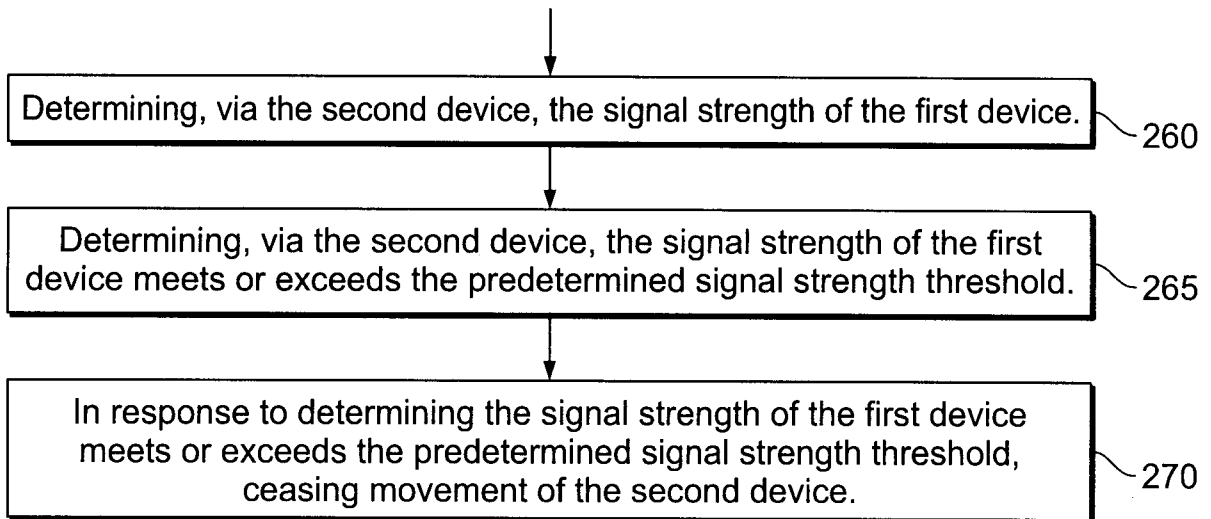


FIG. 7

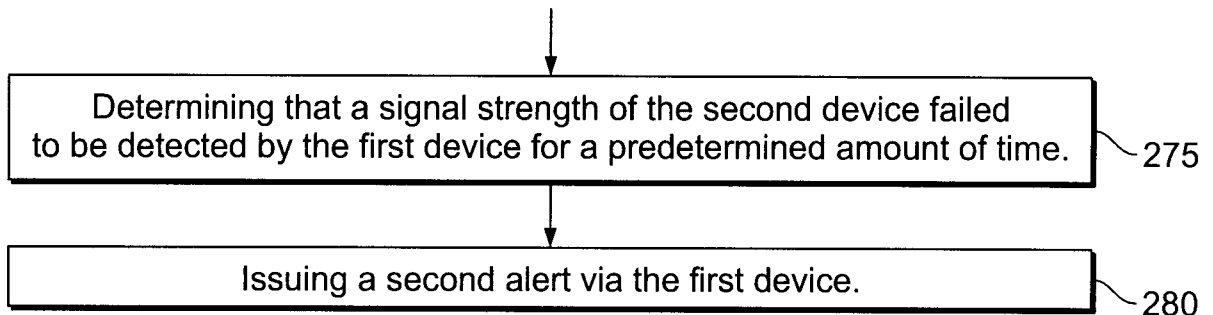


FIG. 8

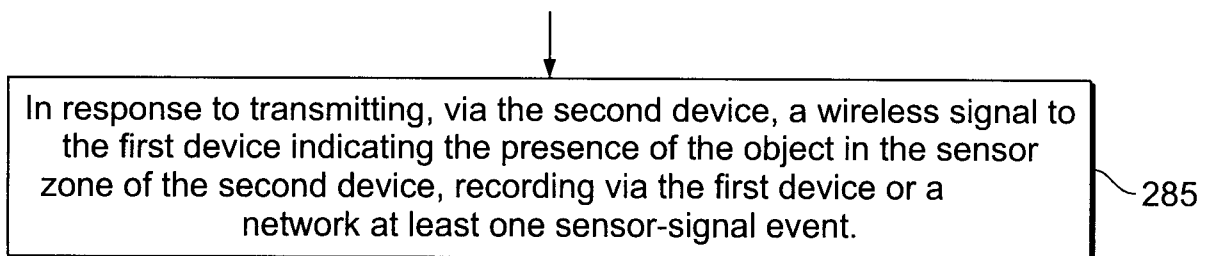


FIG. 9

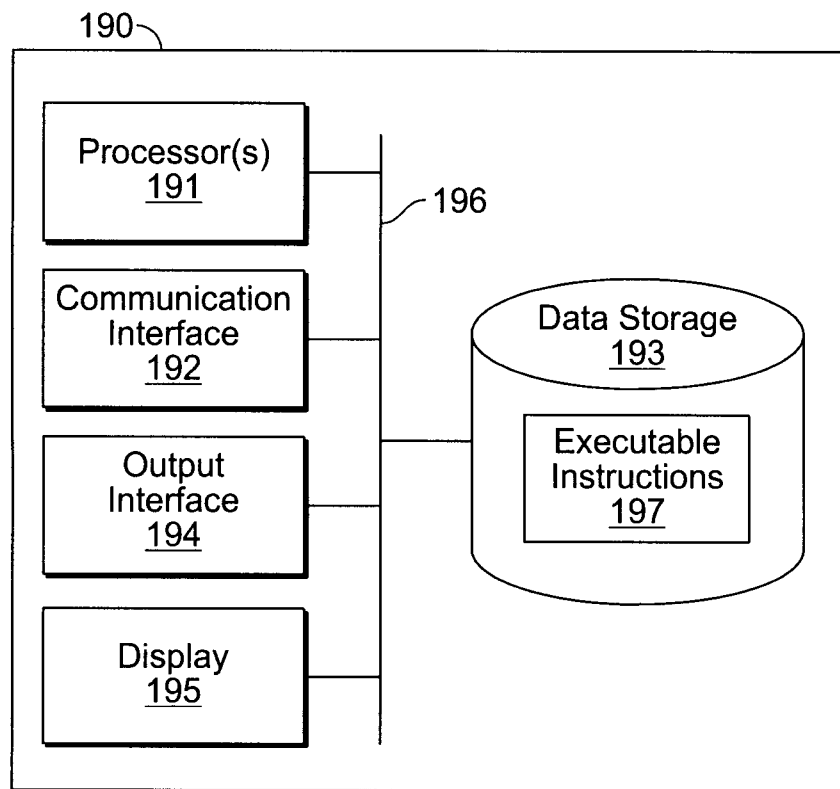


FIG. 10

Network
199

100

Sensor
160

First Alert
Indicator
165

Alignment
Indicator
175

Transmitter
155

Computing
Device
190

Second Device
150

Receiver
110

Computing
Device
198

First Device
105

First Alert
Indicator
115

Alignment
Indicator
170

Second Alert
Indicator
185

Override
Switch
120

Barrier
130

Object
145

Operator
140

