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(54) SYSTEM AND METHOD FOR DISINFECTING AND CHARGING A SENSOR

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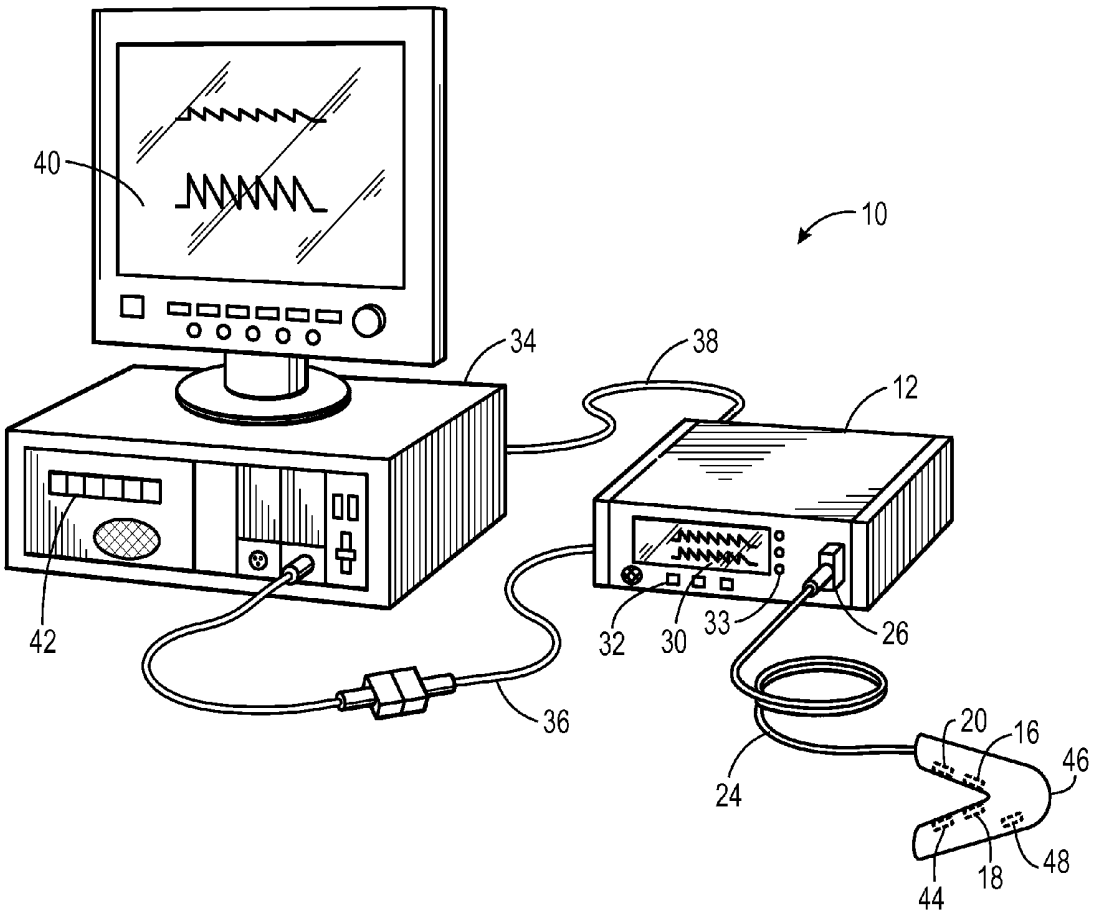
(57) **ABSTRACT**

Methods and systems are provided for disinfecting and recharging a sensor. The sensor may be a wireless sensor, or the sensor may be configured to operate in a wireless mode and in a wired mode. The system may include a charging device configured to provide power to the sensor and/or to recharge a power source of the sensor. The sensor may include a proximity detector configured to provide information relating to a proximity of the sensor to the charging device. Additionally, the sensor may include additional sensors configured to provide information relating to a disinfection process utilized to disinfect the sensor.



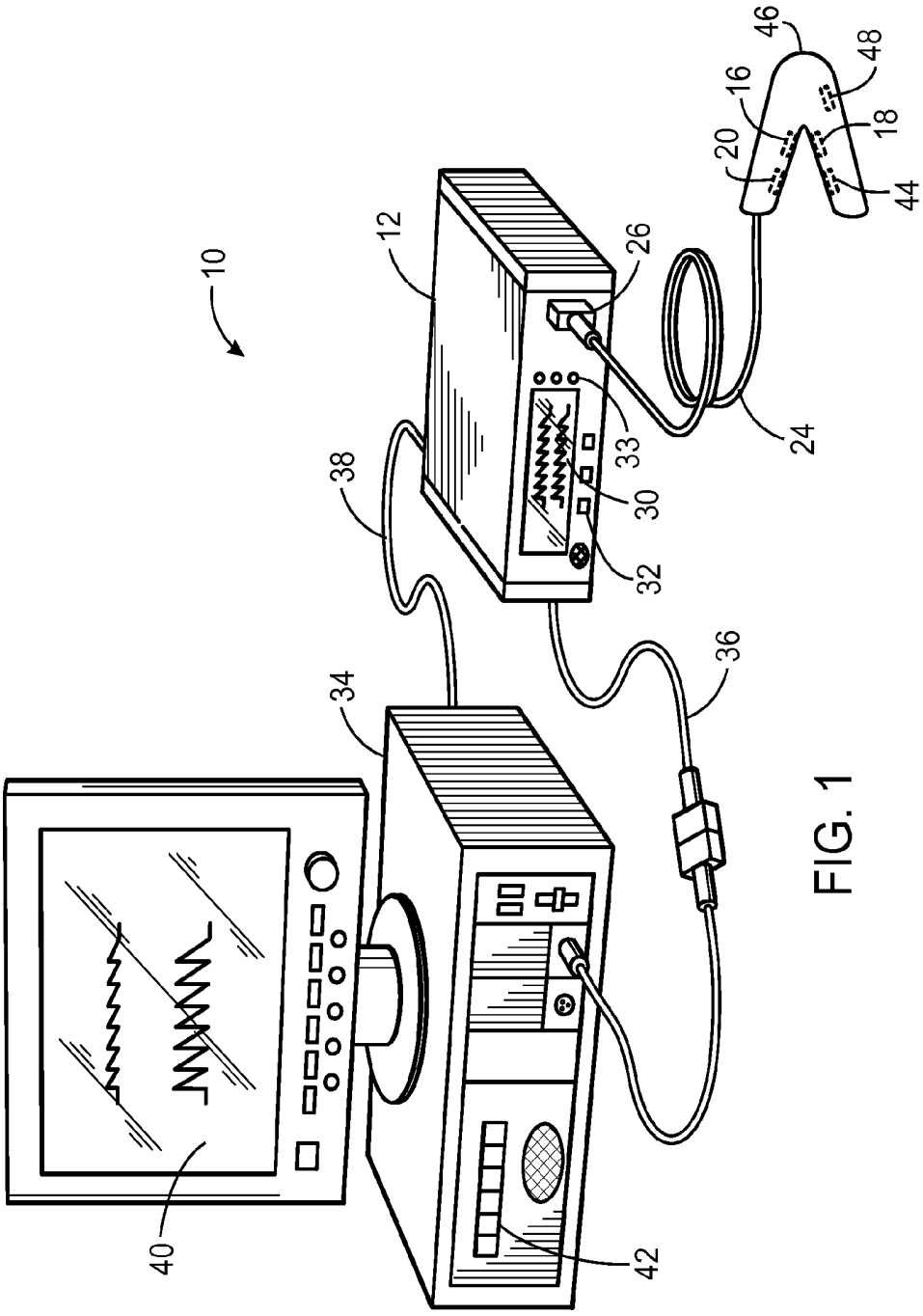


FIG. 1

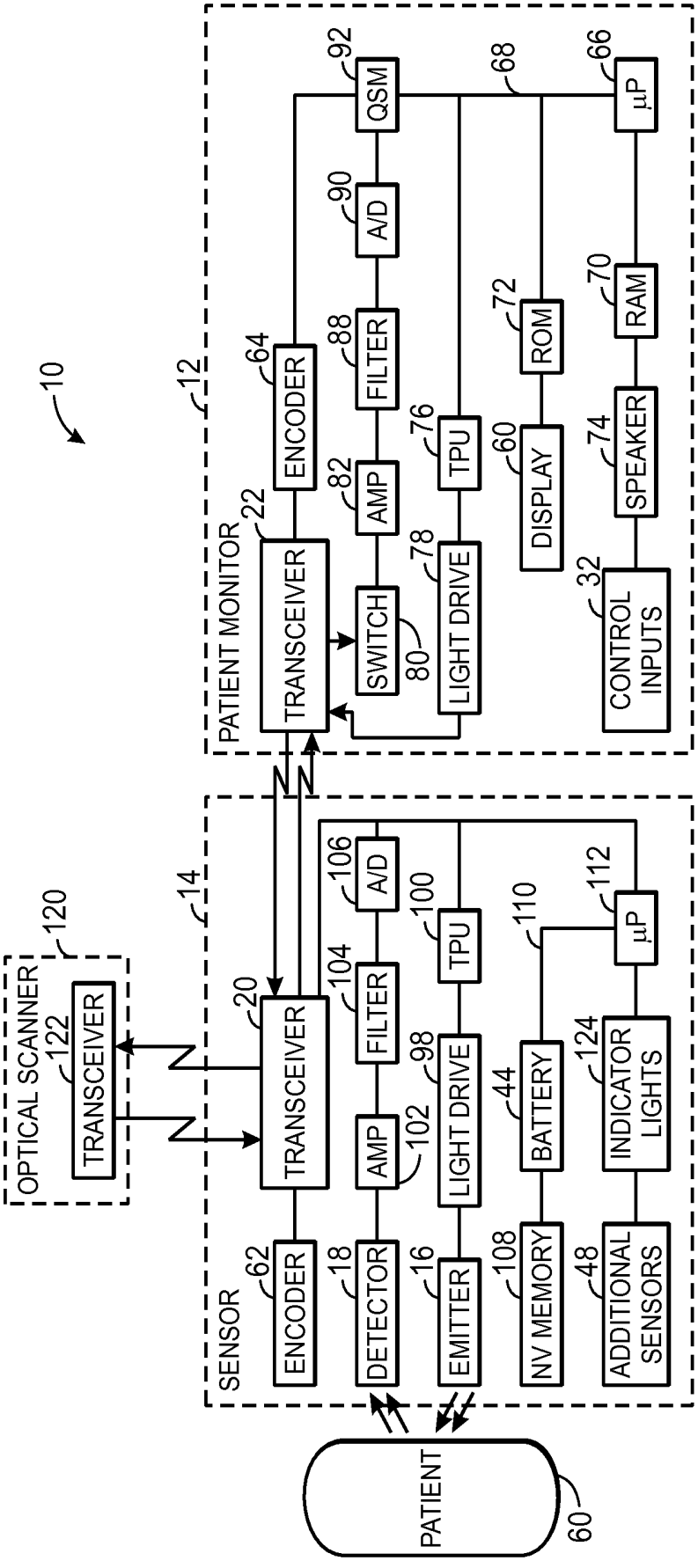

10
12
PATIENT MONITOR
22
TRANSCEIVER
64
ENCODER
88
FILTER
90
A/D
92
QSM
82
AMP
80
SWITCH
78
LIGHT DRIVE
76
TPU
68
60
DISPLAY
72
ROM
66
μP
70
RAM
74
SPEAKER
32
CONTROL INPUTS
14
SENSOR
20
TRANSCEIVER
62
ENCODER
18
DETECTOR
16
EMITTER
104
FILTER
106
A/D
102
AMP
98
LIGHT DRIVE
100
TPU
44
BATTERY
110
NV MEMORY
108
112
μP
124
INDICATOR LIGHTS
48
ADDITIONAL SENSORS
120
OPTICAL SCANNER
122
TRANSCEIVER
PATIENT
60

FIG. 2

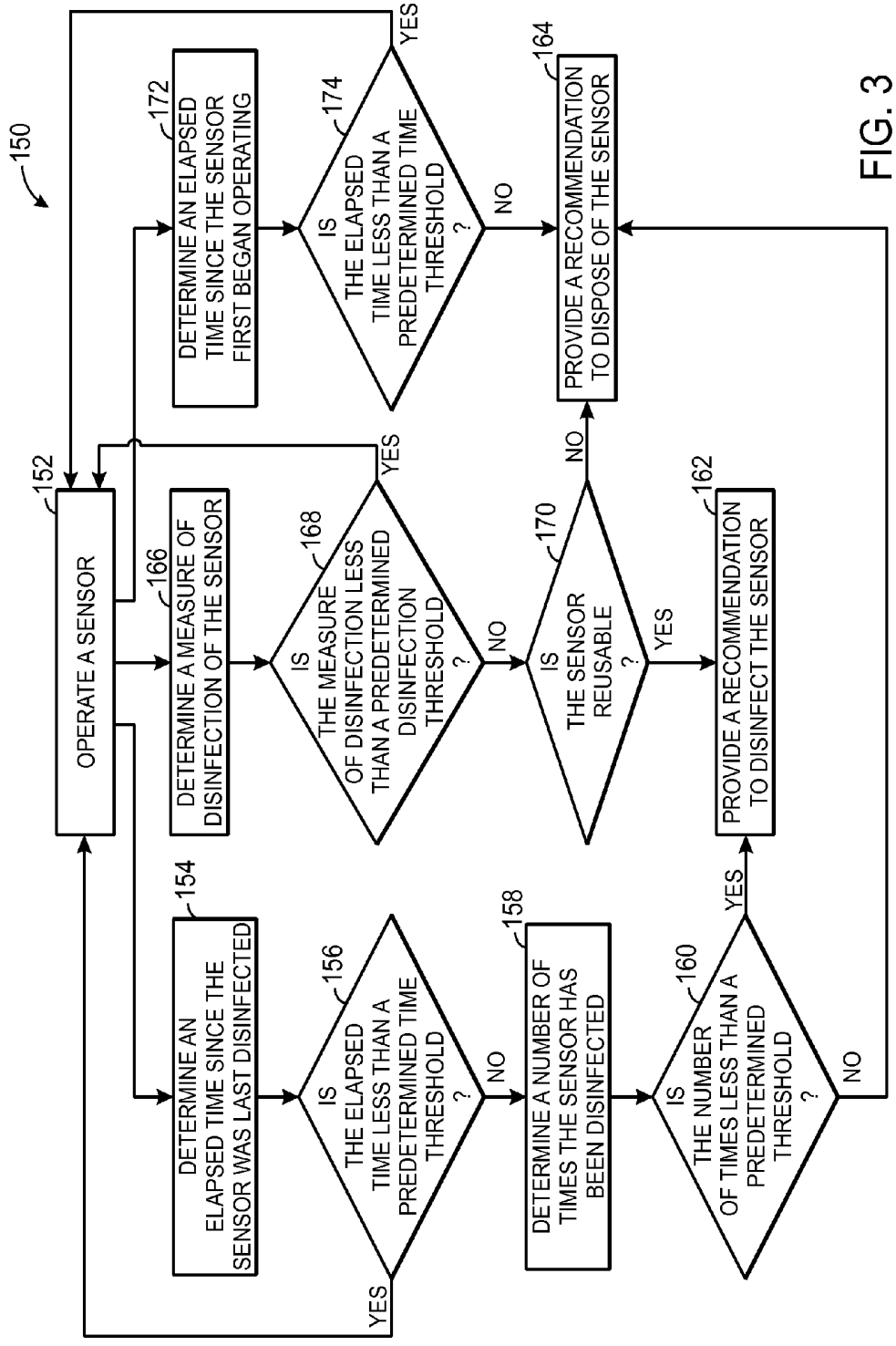

150
152
OPERATE A SENSOR
154
DETERMINE AN ELAPSED TIME SINCE THE SENSOR WAS LAST DISINFECTED
156
IS THE ELAPSED TIME LESS THAN A PREDETERMINED TIME THRESHOLD ?
YES
NO
158
DETERMINE A NUMBER OF TIMES THE SENSOR HAS BEEN DISINFECTED
160
IS THE NUMBER OF TIMES LESS THAN A PREDETERMINED THRESHOLD ?
YES
NO
162
PROVIDE A RECOMMENDATION TO DISINFECT THE SENSOR
166
DETERMINE A MEASURE OF DISINFECTION OF THE SENSOR
168
IS THE MEASURE OF DISINFECTION LESS THAN A PREDETERMINED DISINFECTION THRESHOLD ?
YES
NO
170
IS THE SENSOR REUSABLE ?
YES
NO
164
PROVIDE A RECOMMENDATION TO DISPOSE OF THE SENSOR
172
DETERMINE AN ELAPSED TIME SINCE THE SENSOR FIRST BEGAN OPERATING
174
IS THE ELAPSED TIME LESS THAN A PREDETERMINED TIME THRESHOLD ?
YES
NO

FIG. 3

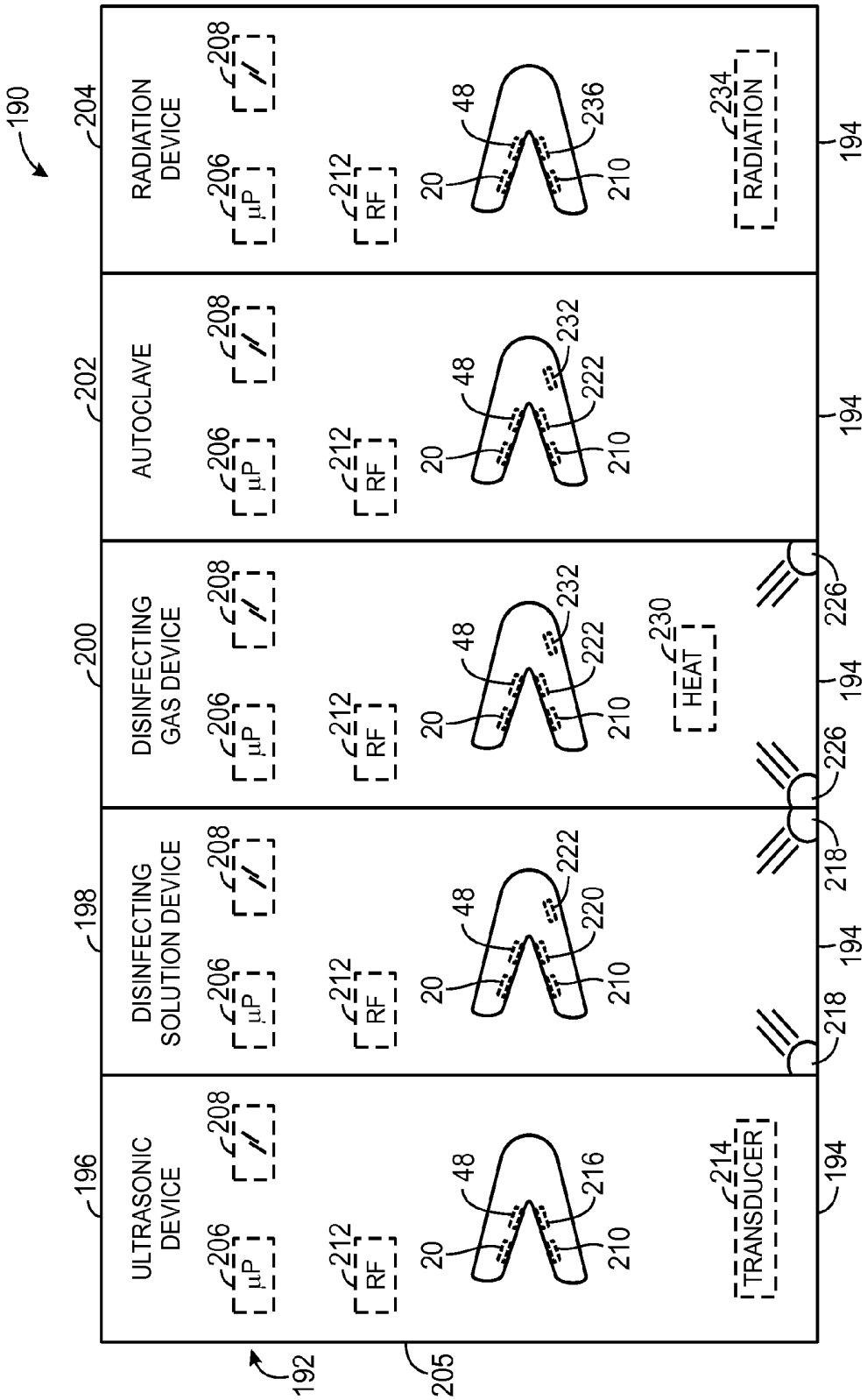

190
192
205
196
ULTRASONIC DEVICE
198
DISINFECTING SOLUTION DEVICE
200
DISINFECTING GAS DEVICE
202
AUTOCLAVE
204
RADIATION DEVICE
206 µP
208
212 RF
214 TRANSDUCER
216
218
220
222
226
230 HEAT
232
234 RADIATION
236
194
20
48
210

FIG. 4

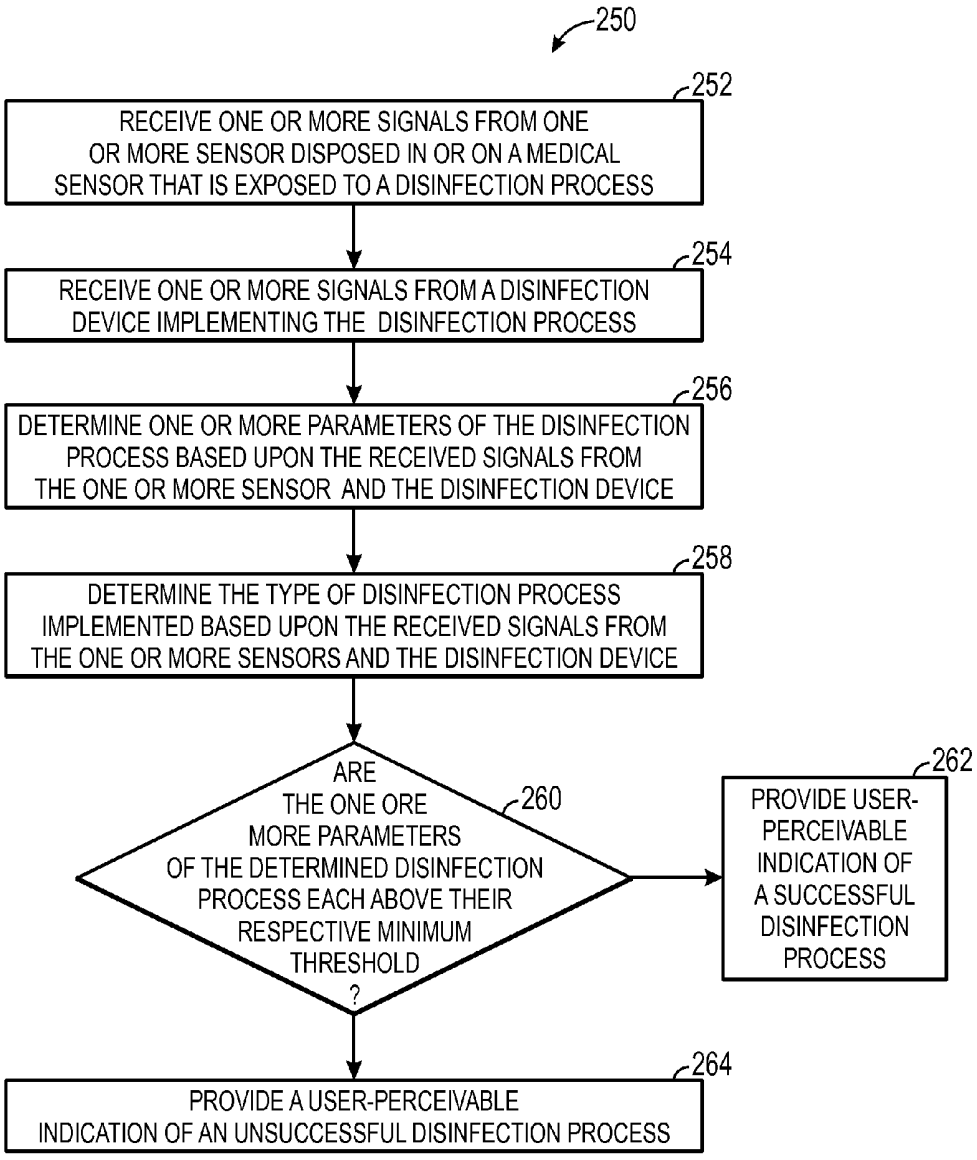

250
252
RECEIVE ONE OR MORE SIGNALS FROM ONE OR MORE SENSOR DISPOSED IN OR ON A MEDICAL SENSOR THAT IS EXPOSED TO A DISINFECTION PROCESS
254
RECEIVE ONE OR MORE SIGNALS FROM A DISINFECTION DEVICE IMPLEMENTING THE DISINFECTION PROCESS
256
DETERMINE ONE OR MORE PARAMETERS OF THE DISINFECTION PROCESS BASED UPON THE RECEIVED SIGNALS FROM THE ONE OR MORE SENSOR AND THE DISINFECTION DEVICE
258
DETERMINE THE TYPE OF DISINFECTION PROCESS IMPLEMENTED BASED UPON THE RECEIVED SIGNALS FROM THE ONE OR MORE SENSORS AND THE DISINFECTION DEVICE
ARE THE ONE ORE MORE PARAMETERS OF THE DETERMINED DISINFECTION PROCESS EACH ABOVE THEIR RESPECTIVE MINIMUM THRESHOLD ?
260
262
PROVIDE USER-PERCEIVABLE INDICATION OF A SUCCESSFUL DISINFECTION PROCESS
264
PROVIDE A USER-PERCEIVABLE INDICATION OF AN UNSUCCESSFUL DISINFECTION PROCESS

FIG. 5

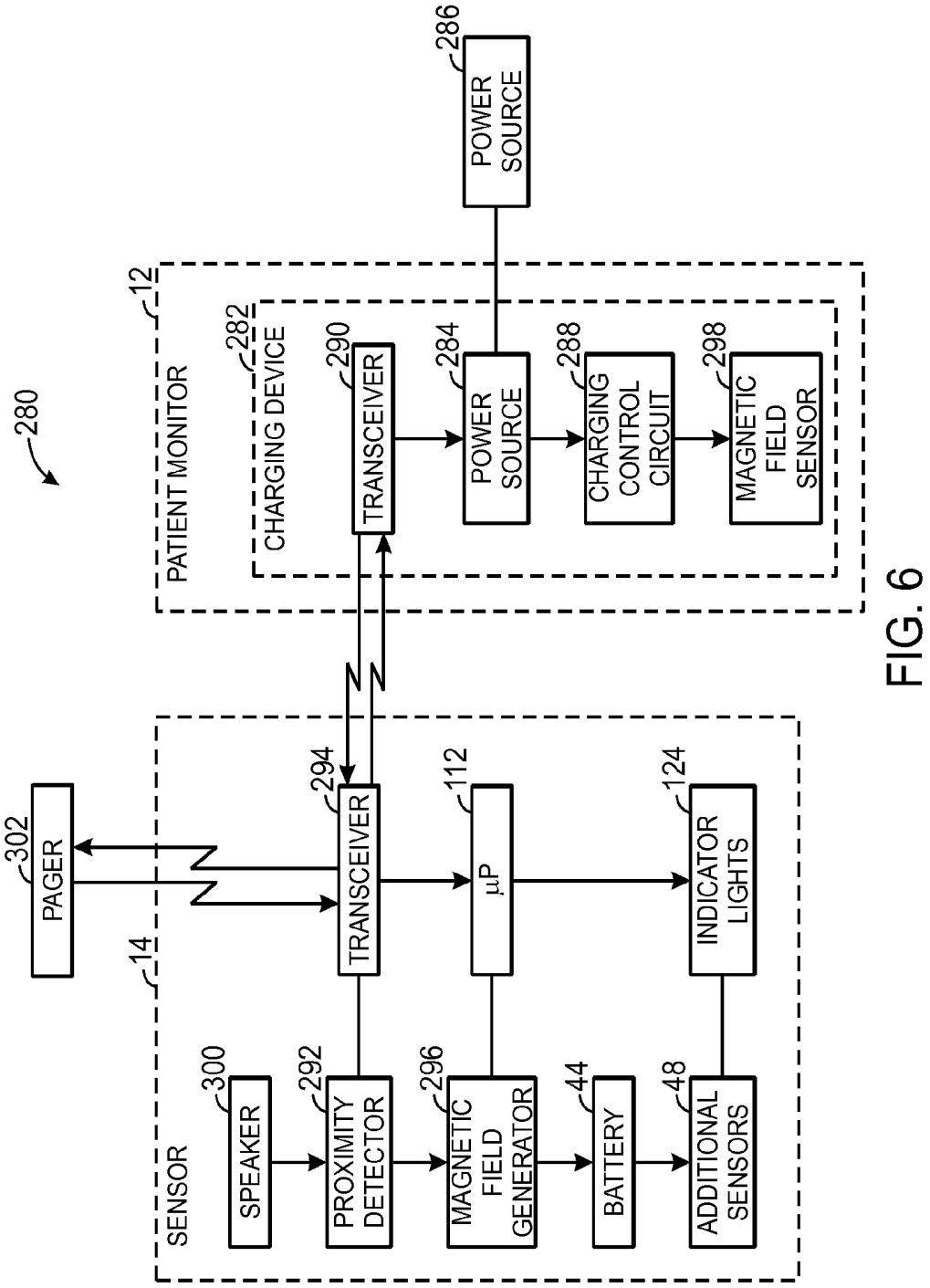

280
PATIENT MONITOR
12
CHARGING DEVICE
282
TRANSCEIVER
290
POWER SOURCE
284
CHARGING CONTROL CIRCUIT
288
MAGNETIC FIELD SENSOR
298
POWER SOURCE
286
SENSOR
14
PAGER
302
TRANSCEIVER
294
µP
112
INDICATOR LIGHTS
124
SPEAKER
300
PROXIMITY DETECTOR
292
MAGNETIC FIELD GENERATOR
296
BATTERY
44
ADDITIONAL SENSORS
48

FIG. 6

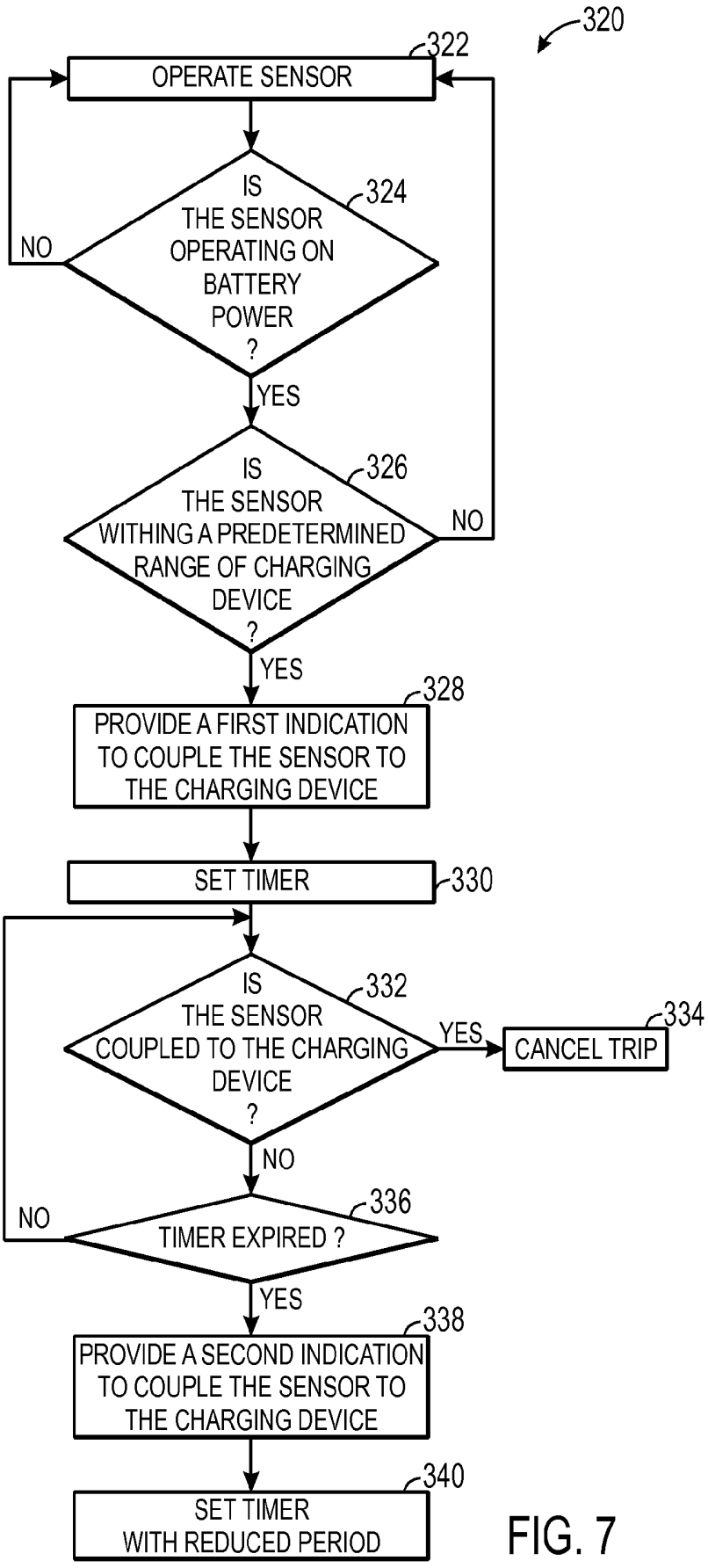

320
322
OPERATE SENSOR
IS THE SENSOR OPERATING ON BATTERY POWER ?
324
NO
YES
IS THE SENSOR WITHING A PREDETERMINED RANGE OF CHARGING DEVICE ?
326
NO
YES
328
PROVIDE A FIRST INDICATION TO COUPLE THE SENSOR TO THE CHARGING DEVICE
SET TIMER
330
IS THE SENSOR COUPLED TO THE CHARGING DEVICE ?
332
YES
334
CANCEL TRIP
NO
NO
TIMER EXPIRED ?
336
YES
338
PROVIDE A SECOND INDICATION TO COUPLE THE SENSOR TO THE CHARGING DEVICE
340
SET TIMER WITH REDUCED PERIOD

FIG. 7

SYSTEM AND METHOD FOR DISINFECTING AND CHARGING A SENSOR

BACKGROUND

[0001] The present disclosure relates generally to medical devices, and more particularly, to medical devices that monitor physiological parameters of a patient, such as pulse oximeters.

[0002] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present disclosure, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present disclosure. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0003] In the field of medicine, doctors often desire to monitor certain physiological characteristics of their patients. Accordingly, a wide variety of devices have been developed for monitoring many such physiological characteristics. Such devices provide doctors and other healthcare personnel with the information they need to provide the best possible healthcare for their patients. As a result, such monitoring devices have become an indispensable part of modern medicine.

[0004] One technique for monitoring certain physiological characteristics of a patient is commonly referred to as pulse oximetry, and the devices built based upon pulse oximetry techniques are commonly referred to as pulse oximeters. Pulse oximetry may be used to measure various blood flow characteristics, such as the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and/or the rate of blood pulsations corresponding to each heartbeat of a patient. In fact, the "pulse" in pulse oximetry refers to the time varying amount of arterial blood in the tissue during each cardiac cycle.

[0005] Pulse oximeters and other types of monitoring devices may use either disposable sensors, which are discarded after a single use, or reusable sensors. Reusable sensors may lower the overall cost of the sensor per use; however, reusable sensors must be thoroughly disinfected before use with a new patient and/or periodically throughout use with the same patient. Unfortunately, users may experience difficulty in remembering whether a sensor has been disinfected (e.g., before providing the sensor to a new patient) and/or how much time has elapsed since a sensor was last disinfected.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Advantages of the disclosed techniques may become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0007] FIG. **1** illustrates a perspective view of a patient monitoring system including a patient monitor and a sensor, in accordance with an embodiment;

[0008] FIG. **2** illustrates a block diagram of the patient monitoring system of FIG. **1**, including the patient monitor and the sensor of FIG. **1**, and an optical scanner, in accordance with an embodiment;

[0009] FIG. **3** illustrates a flow diagram of a method for determining a disinfection condition of the sensor of FIG. **1**, in accordance with an embodiment;

[0010] FIG. **4** illustrates a schematic diagram of a disinfecting system for disinfecting the sensor of FIG. **1**, in accordance with an embodiment;

[0011] FIG. **5** illustrates a flow diagram of a method for determining information related to a disinfection process for the sensor of FIG. **1**, in accordance with an embodiment;

[0012] FIG. **6** illustrates a block diagram of patient monitoring system of FIG. **1**, including the patient monitor and the sensor of FIG. **1**, and a charging device, in accordance with an embodiment; and

[0013] FIG. **7** illustrates a flow diagram of a method for providing an indication to couple the sensor of FIG. **1** to a charging device, in accordance with an embodiment.

DETAILED DESCRIPTION OF THE SPECIFIC EMBODIMENTS

[0014] One or more specific embodiments of the present techniques will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

[0015] As noted above, reusable sensors may be disinfected periodically. For example, the sensor may be disinfected periodically throughout use with the same patient and/or before use with a new patient. However, users may experience difficulty in remembering whether a sensor has been disinfected (e.g., before providing the sensor to a new patient) and/or how much time has elapsed since a sensor was last disinfected. Additionally, while reusable sensors may be periodically disinfected, a user may not be provided with information regarding the disinfection process for the sensor. Information regarding the disinfection process may be useful for quality control purposes. For example, if a disinfection system is faulty, it may be desirable to disinfect the sensor again and/or provide the sensor to a different disinfection system.

[0016] To address these issues, the present embodiments describe sensors that may be equipped with processing circuitry configured to monitor and/or determine a disinfection condition and to provide an indication of the disinfection condition. In particular, a sensor may include at least two disinfection conditions (e.g., states or statuses). A first disinfection condition may indicate that continued sensor operation may be acceptable, and a second disinfection condition may indicate that disinfecting or disposing of the sensor may be desirable. In some embodiments, a reusable sensor may be configured to determine the time that has elapsed since the last disinfection. The reusable sensor may provide an indication that disinfection may be desirable if the time that has elapsed since the last disinfection is greater than a predetermined threshold. Similarly, a disposable sensor (e.g., single use sensor) may be configured to determine the time that has elapsed since the sensor has been in use and, further, may be configured to provide an indication that disposal of the sensor may be desirable if the time that has elapsed is greater than a predetermined threshold. Thus, the present embodiments may alert the user when it may be desirable to disinfect a reusable sensor and/or to dispose of a disposable sensor.

[0017] Additionally, the sensor may include one or more additional sensors that may be configured to provide information (e.g., quality information) regarding a disinfection process utilized to disinfect the sensor. For example, in certain embodiments, the sensor may include a temperature sensor and/or a pressure sensor, which may detect that the sensor is being disinfected (e.g., via high temperatures and/or pressures). Additionally, the sensor may be equipped with a transceiver to wirelessly communicate with a disinfection system. In this manner, the sensor may determine (e.g., via a signal from the disinfection system) that it is being disinfected. Further, the sensor may be configured to provide an indication of a completed disinfection process to the user. Additionally, the sensor may be configured to provide an indication relating to the quality of the completed disinfection process to the user. Thus, the present embodiments may provide the user with a confirmation of a completed disinfection process and information regarding the disinfection process. Embodiments such as these are discussed with respect to FIGS. **1-5**.

[0018] However, monitoring the disinfection condition of the sensor and monitoring the disinfection process may increase the power consumption of the sensor. Additionally, the sensor may operate using battery power during certain disinfection processes that may not be conducive to cables. As a result, for embodiments in which the sensor utilizes a battery as a power source, problems may exist in which the battery may drain, and the battery must be recharged or replaced to continue sensor operation. Accordingly, it may be desirable to provide sensors which may operate using both battery power and wired power from a charging device. For example, the sensor may include a power connector to receive a cable of a charging device and may operate using power received from the charging device while the cable is coupled to the power connector. The sensor may operate using battery power while the cable is not connected to the power connector. To minimize battery drainage, it may be desirable to minimize battery use and operate using wired power when the reusable sensor is within range of a charging device. Occasionally, the user and/or the patient may forget to attach the sensor to the cable of the charging device when the sensor is within range of the charging device.

[0019] To address this issue, the present embodiments describe a sensor that detects when it is within a predetermined range of a charging device and provides an indication to a user that the sensor is within the predetermined range. For example, the charging device may include a short-range wireless transmitter, and the sensor may include a short-range wireless reader that may read a signal transmitted by the short-range wireless transmitter when the sensor is within a predetermined range of the charging device. Additionally, the sensor may be configured to provide an indication to the user based in part upon the received signal from the charging device. For example, the sensor may include an indicator light that may emit and/or flash light in response to determining that the sensor is within the predetermined range. Embodiments such as these are discussed with respect to FIGS. **6** and **7**.

[0020] With the foregoing in mind, FIG. **1** illustrates an embodiment of a patient monitoring system **10** that may include a patient monitor **12** and a sensor **14**, such as a pulse oximetry sensor, to monitor physiological parameters of a patient. By way of example, the sensor **14** may represent a MAXFAST™, NEOMAX™, or other pulse oximetry sensor available from Covidien LP. Although the depicted embodiments relate to sensors for use on a patient's fingertip, toe, or earlobe, it should be understood that, in certain embodiments, the features of the sensor **14** as provided herein may be incorporated into sensors for use on other tissue locations, such as the forehead and/or temple, the heel, stomach, chest, back, or any other appropriate measurement site. In addition, although the embodiment of the patient monitoring system **10** illustrated in FIG. **1** relates to photoplethysmography or pulse oximetry, the patient monitoring system **10** may be configured to obtain a variety of medical measurements with a suitable medical sensor. For example, the patient monitoring system **10** may additionally or alternatively be configured to perform regional oximetry, determine patient electroencephalography (e.g., a bispectral (BIS) index), or any other physiological parameter such as tissue water fraction or hematocrit.

[0021] The sensor **14** may include one or more emitters **16** and one or more detectors **18** to acquire a physiological signal corresponding to one or more physiological parameters of a patient. For pulse oximetry applications, the emitter **16** may transmit at least two wavelengths of light (e.g., red and/or infrared (IR)) into a tissue of the patient. The detector **18** may be a photodetector selected to receive light in the range emitted from the emitter **18** after it has passed through the tissue. Additionally, the emitter **16** and the detector **18** may operate in various modes (e.g., reflectance or transmission). However, as noted above, the patient monitoring system **10** may be configured to determine a variety of physiological parameters with a suitable medical sensor. Accordingly, in certain embodiments, the sensor **14** may include sensing components in addition to, or instead of, the emitter **16** and the detector **18**. For example, in one embodiment, the sensor **14** may include one or more electrodes (e.g., four electrodes) to obtain an electroencephalography signal.

[0022] The sensor **14** may be communicatively coupled to the patient monitor **12**. In certain embodiments, the sensor **14** may include a wireless module configured to establish a wireless communication with the patient monitor **12** using any suitable wireless standard. For example, the sensor **14** may include a transceiver **20** that may enable wireless operation signals to be transmitted to and received from an external device (e.g., the patient monitor **12**, a charging device, a disinfecting device, etc.). The transceiver **20** may establish wireless communication with a transceiver **22** of the patient monitor using any suitable protocol. For example, the transceiver **20** may be configured to transmit signals using one or more of the ZigBee standard, WirelessHART standard, Bluetooth standard, IEEE 802.11x standards, or MiWi standard. Additionally, the transceiver **20** may transmit a raw digitized detector signal, a processed digitized detector signal, and/or a calculated physiological parameter, as well as any data that may be stored in the sensor, such as data relating to a disinfection status of the sensor **10** and/or data relating to a disinfection process, as discussed below. Additionally or alternatively, the emitters **16** and detectors **18** of the sensor **14** may be coupled to the patient monitor **12** via a cable **24** through a plug **26** (e.g., a connector having one or more conductors) coupled to a sensor port. Thus, in certain embodiments, the sensor **14** may be configured to operate in both a wireless mode and a wired mode. Accordingly, in certain embodiments, the cable **24** may be removably attached to the sensor **14** via a connector **28** (e.g., a plug or a magnet), which may increase the patient's range of motion while wearing the sensor **14**.

[0023] The patient monitor **12** may be configured to calculate physiological parameters of the patient relating to the physiological signal received from the sensor **14**. For example, the patient monitor **12** may include a processor configured to calculate the patient's arterial blood oxygen saturation, pulse rate, respiration rate, blood pressure, blood pressure characteristic measure, a bispectral index, and/or any other suitable physiological characteristics. Additionally, the patient monitor **12** may include a monitor display **30** configured to display information regarding the physiological parameters, information about the system (e.g., instructions for disinfecting and/or charging the sensor **14**), and/or alarm indications. The patient monitor **12** may include various input components **32**, such as knobs, switches, keys and keypads, buttons, etc., to provide for operation and configuration of the patient monitor **12**. The patient monitor **12** may also display information related to alarms, monitor settings, and/or signal quality via one or more indicator lights **33**.

[0024] As noted above, the patient monitor **12** may be any suitable monitor, such as a pulse oximetry monitor. Furthermore, to upgrade the conventional operation provided by the patient monitor **12** and to provide additional functions, the patient monitor **12** may be coupled to a multi-parameter monitor **34** via a cable **36** connected to a sensor input port or via a cable **38** connected to a digital communication port. In addition to the patient monitor **12**, or alternatively, the multi-parameter monitor **34** may be configured to calculate physiological parameters and to provide a central display **40** for the visualization of information from the patient monitor **12** and from other medical monitoring devices or systems. The multi-parameter monitor **34** includes a processor that may be configured to execute code for calculating one or more physiological parameters and displaying the physiological parameters and/or other information about the patient monitoring system **10**. The multi-parameter monitor **34** may also include various input components **42**, such as knobs, switches, keys and keypads, buttons, etc., to provide for operation and configuration of the multi-parameter monitor **34**. In addition, the patient monitor **12**, the multi-parameter monitor **34**, and/or the sensor **14** may be connected to a network to enable the sharing of information with servers or other workstations.

[0025] Because the sensor **14** may be configured to operate in a wireless mode and, in certain embodiments, may not receive power from the patient monitor **12** while operating in the wireless mode, the sensor **14** may include a battery **44** to provide power to the components of the sensor **14** (e.g., the emitter **16** and the detector **18**). In certain embodiments, the battery **44** may be a rechargeable battery such as, for example, a lithium ion, lithium polymer, nickel-metal hydride, or nickel-cadmium battery. However, any suitable power source may be utilized, such as, one or more capacitors and/or an energy harvesting power supply (e.g., a motion generated energy harvesting device, thermoelectric generated energy harvesting device, or similar devices).

[0026] The sensor **14** may also include a sensor body **46** to house the components of the sensor **14** (e.g., the emitter **16**, the detector **18**, the transceiver **20**, and/or the battery **44**). In certain embodiments, the sensor body **46** may be formed from any suitable material that can be disinfected and/or may be shaped to minimize or eliminate crevices to facilitate disinfecting of the sensor **14**. In particular, the sensor body **46** may be resistant to or may prevent fluid infiltration. For example, the sensor body **46** may be formed from rigid or conformable materials, such as rubber or elastomeric compositions (including acrylic elastomers, polyimide, silicones, silicone rubber, celluloid, PMDS elastomer, polyurethane, polypropylene, acrylics, nitrile, PVC films, acetates, and latex). Further, the sensor **14** may be formed from molded or overmolded components. Additionally, the sensor body **46** may include a cover (e.g., a flap) that may be at least partially removed from the sensor body **46** and may cover and/or protect the connector **28** from a disinfecting agent, when the connector **28** is not coupled to the cable **24**. In other embodiments, the sensor **14** may be disposable (e.g., a single-use sensor), and thus, the sensor body **46** may be constructed from any suitable materials, which may not be suitable for disinfecting (e.g., fabric or paper). Further, in other embodiments, the sensor **14** may be partially reusable. For example, the sensor body **46** may include an adhesive layer disposed on a patient-contacting surface of the sensor body **46** (e.g., to attach the sensor **14** to the patient's tissue), and the adhesive layer may be removed and disposed of prior to disinfecting the sensor **14**.

[0027] Additionally, the sensor **10** may include one or more additional sensors **48** disposed on and/or in the sensor body **46**. As will be discussed in more detail below, the one or more additional sensors **48** may generate information relating to a condition of the sensor **14**, and in particular may generate information relating to changes in the condition of the sensor **14** during a disinfection process (e.g., autoclaving and/or exposure to a disinfecting solution and/or disinfecting gas). For example, the one or more additional sensors **48** may be pressure sensors, temperature sensors, moisture sensors, proximity detectors, or any other suitable sensor. The signals generated by the one or more additional sensors **48** may be utilized by the sensor **14** to determine whether the sensor **14** has been disinfected and, in some embodiments, whether the sensor **14** was properly disinfected (e.g., exposed to a predetermined pressure or temperature).

[0028] Turning to FIG. **2**, a block diagram of the patient monitoring system **10** is illustrated in accordance with an embodiment. Specifically, certain components of the sensor **14** and the patient monitor **12** are illustrated in FIG. **2**. As noted above, the sensor **14** may include the emitter **16** and the detector **18**. The emitter **16** may emit light into a patient **60**, which may be reflected by or transmitted through the patient **16** and subsequently detected by the detector **18**. In some embodiments, the emitter **16** may emit one or more different wavelengths of light. For example, the emitter **16** may emit red wavelengths between approximately 600 nanometers (nm) and 700 nm and/or infrared wavelengths between approximately 800 nm and 1000 nm. In other embodiments, the emitter **16** may emit a red wavelength between approximately 620 nm and 700 nm (e.g., 660 nm), a far red wavelength between approximately 690 nm and 770 nm (e.g., 730 nm), and an infrared wavelength between approximately 860 nm and 940 nm (e.g., 900 nm). Other wavelengths may include, for example, wavelengths between approximately 500 nm and 600 nm and/or 1000 nm and 1100 nm. Alternative light sources may be used in other embodiments. For example, a single wide-spectrum light source may be used, and the detector **18** may be configured to detect certain wavelengths of light. In another example, the detector **18** may detect a wide spectrum of wavelengths of light, and the patient monitor **12** may process only those wavelengths which are of interest for use in measuring, for example, water fractions, hematocrit, or other physiologic parameters of the patient **60**. It should be understood that, as used herein, the term "light" may refer to one or more of ultrasound, radio,

microwave, millimeter wave, infrared, visible, ultraviolet, gamma ray, or X-ray electromagnetic radiation, and may also include any wavelength within the radio, microwave, millimeter wave, infrared, visible, ultraviolet, or X-ray spectra, and that any suitable wavelength of light may be appropriate for use with the present disclosure.

[0029] Additionally, the sensor **14** may include an encoder **62**, which may contain information about the sensor **14**. For example, the encoder **62** may contain information regarding what type of sensor it is (e.g., whether the sensor is intended for placement on a forehead or digit) and the wavelengths of light emitted by the emitter **16**. This information may enable the patient monitor **12** to select appropriate algorithms and/or calibration coefficients for calculating the physiological characteristics of the patient **60**. Additionally, the encoder **62** may include information relating to proper disinfecting of the sensor **14**. For example, the encoder **62** may include information relating to the number of times the sensor **14** has been disinfected and/or the type of disinfecting agents (e.g., an autoclave, solutions, and/or gases) that may be used to disinfect the sensor **14**. In one embodiment, the encoder **62** may store information relating to the type of sensor **14**, such as, for example, whether the sensor **14** is reusable, partially reusable, or disposable. In some embodiments, the encoder **62** may also store information relating to a minimum pressure threshold and/or a minimum temperature threshold, or any other suitable threshold that the sensor **14** may be exposed to during a disinfecting process to determine whether the sensor **14** was properly disinfected during the disinfection process. The encoder **62** may also be programmed with information relating to the battery **44** such as, for example, the type of battery **44** utilized and an approximate use time for the battery **44** before the battery **44** may be drained. The encoder **62** may, for instance, be a memory, a coded resistor, EEPROM, or other coding devices that may provide a signal to the patient monitor **12** relating to the characteristics of the sensor **14**. The patient monitor **12** may include a reader/decoder **64** that may read and/or decode information from the encoder **62** to provide the patient monitor **12** with information about the sensor **14**.

[0030] In one implementation, signals from the detector **18** (and data from the encoder **62**, if present) may be transmitted to the patient monitor **12** via the transceiver **20** and/or the cable **24**. The patient monitor **12** may include data processing circuitry (such as one or more processors **66**, application specific integrated circuits (ASICS), or so forth) coupled to an internal bus **68**. Also connected to the bus **68** may be a RAM memory **70**, a ROM memory **72**, a speaker **74**, the transceiver **22**, the display **30**, and/or the input components **32**. In one embodiment, a time processing unit (TPU) **76** may provide timing control signals to light drive circuitry **78**, which may control the operation of the emitter **16**, such as to control when, for how long, and/or how frequently the emitter **16** is activated, and if multiple light sources are used, the multiplexed timing for the different light sources.

[0031] The TPU **76** may also control the gating-in of signals from the detector **18** through a switching circuit **80**. These signals may be sampled at the proper time, depending upon which light source is illuminated. The received signal from the detector **18** may be passed through an amplifier **82**, a low pass filter **88**, and an analog-to-digital converter (A/D) **90** for amplifying, filtering, and digitizing the signals from the sensor **14**. The digital data may then be stored in a queued serial module (QSM) **92** for later downloading to the RAM **70** as the QSM **92** fills up. In an embodiment, there may be multiple parallel paths of separate amplifier, filter, and A/D converters for multiple wavelengths or spectra received.

[0032] In some embodiments, in addition to or instead of the patient monitor **12**, the sensor **14** may be configured to control the acquisition of the physiological signal, to process the physiological signal, and/or to calculate one or more physiological parameters based upon the physiological signal. This may be advantageous in certain scenarios in which the sensor **14** is moved outside of the wireless range of the patient monitor **12** (e.g., a patient steps outside of the room) and sensor operation is still desired. In such embodiments, the sensor **14** may include a light drive **98** configured to drive the emitter **16** and the detector **18** based upon control signals based upon control signals from a TPU **100** of the sensor **14**. The light drive **98** may also be configured to operate based upon control signals received from the patient monitor **12** via the transceiver **20** (e.g., when the sensor **14** is within the wireless range of the patient monitor **12**). The TPU **100** may operate in a similar manner as the TPU **76**. The received signal from the detector **18** may be passed through an amplifier **102**, a low pass filter **104**, and an analog-to-digital converter **106**. The digital data may then be stored in a non-volatile (NV) memory **108**, which may be coupled to the main system bus **110**. Additionally, the NV memory **108** may also store historical data and/or values (e.g., detector signal data, data points, trend information, etc.) for the physiological parameter of the patient. In certain embodiments, as will be described in more detail below, the sensor **14** may be configured to store raw digital data and/or minimally processed data in the NV memory **108** for transmitting to the patient monitor **12** for further processing and/or calculating of physiological parameters when the sensor **14** is placed in operational proximity of the patient monitor **12**. In this manner, the sensor **14** may minimize power consumption while operating wirelessly. Additionally, in certain embodiments, the sensor **14** may also include data processing circuitry (such as one or more processors **112**, application specific integrated circuits (ASICS), or so forth) coupled to the internal bus **110** for additional signal processing and/or calculating of physiological parameters.

[0033] Regardless of the degree of processing performed by the sensor **14**, in certain embodiments, based at least in part upon the received signals corresponding to the light received by the detector **18**, the processor **66** may calculate physiological characteristics of the patient **60**, such as the oxygen saturation of the patient **60**, using various algorithms. These algorithms may use coefficients, which may be empirically determined, and may correspond to the wavelengths of light used. The algorithms may be stored in the ROM **72** and accessed and operated according to processor **66** instructions. As noted above, the patient monitor **12** may also receive information from the encoder **62**, which may be decoded by the decoder **64** and provided to the processor **66**. In particular, the decoded signals may provide information to the processor **66** such as the sensor type and the wavelengths of light emitted by the emitter **16**, so that proper calibration coefficients and/or algorithms to be used for calculating physiological characteristics of the patient **60** may be selected and utilized by the processor **66**.

[0034] As noted above, the sensor **14** may also include one or more additional sensors **48**, which may be configured to generate information relating to a condition of the sensor **14**. For example, the one or more additional sensors **48** may

include temperature sensors, pressure sensors, moisture sensors, proximity detectors, ultrasonic detectors, colorant bacterial indicators, or any other suitable sensor configured to provide information relating to a condition of the sensor **14**. In certain embodiments, the sensor **14** may be configured to transmit one or more signals generated by the one or more additional sensors **48** to the patient monitor **12** for processing and/or the calculation of one or more parameters as described herein. In other embodiments, the processor **112** and/or other data processing circuitry of the sensor **14** may be configured to process the one or more signals and to calculate the one or more parameters based on the signals.

[0035] In particular, the processor **112** may utilize signals generated by the additional sensors **48** to determine a disinfection condition of the sensor **14**. As noted above, a first disinfection condition of the sensor **14** may indicate that continued sensor operation is acceptable, and a second disinfection condition may indicate that disinfecting the sensor **14** (if reusable) or disposing of the sensor **14** (if disposable) may be desirable. The processor **112** may also utilize signals generated by the additional sensors **48** to monitor changes in a condition (e.g., pressure, temperature, etc.) of the sensor **14** during a disinfecting process, which will be described in more detail below with respect to FIG. **4**. However, it should be noted that in some embodiments, the sensor **14** may include data processing circuitry configured to determine the disinfection condition of the sensor **14** and/or to monitor changes in the condition of the sensor **14** during a disinfection process, rather than the processor **112**.

[0036] For example, in certain embodiments, the additional sensors **48** may include one or more colorant bacterial indicators that may be configured to change colors in the presence of various bacteria. The colorant bacterial indicators may, for example, include a substrate and/or absorbent pad impregnated with a solution that may undergo a color change in the presence of the bacteria. A color change may occur due to a change in the pH of the solution and/or an increase in carbon dioxide and/or other by-products of bacterial growth in the solution. By way of example, the solution may include a solvatochromic dye and/or a pH indicator. The resulting color change may be visually detected by a user; however, the user may experience difficulty in discerning subtle gradations of the color change, which may provide information relating to the measure (e.g., grade or degree) of disinfection and may be useful in determining whether it may be desirable to disinfect the sensor **14**.

[0037] Accordingly, in certain embodiments, the patient monitoring system **10** may include an optical scanner **120**, such as a hand-held scanner, which may be configured to scan the colorant bacterial indicator and generate a signal based at least in part upon the color of the colorant bacterial indicator. The optical scanner **120** may transmit the signal to the sensor **14** and/or the patient monitor **12** via a transceiver **122** or a wired connection for further processing. In one embodiment, the processor **112** of the sensor **14** may determine a measure of disinfection of the sensor **14** based on the signal received from the optical scanner **120** and may compare the measure of disinfection to a predetermined threshold for disinfection. The processor **112** may determine that the sensor **14** may correspond to the second disinfection condition, in which disinfection and/or disposal may be desirable, in response to determining that the measure of disinfection exceeds the predetermined threshold. Additionally, the sensor **14** may provide a user-perceivable indication of the disinfection condition (e.g., the second disinfection condition). The user-perceivable indication may be a visual indication via one of the one or more indicator lights **124**, which may alert the user that it may be desirable to disinfect the sensor **14**. It should be noted that any suitable indication may be provided, such as an audible indication via a speaker and/or a graphical or textual indication via a display. In other embodiments, the optical scanner **120** and/or the patient monitor **12** may be configured to determine the measure of disinfection of the sensor **14**, to determine whether the measure of disinfection of the sensor **14** exceeds the predetermined threshold for disinfection, and/or to provide the user-perceivable indication.

[0038] Additionally or alternatively, the processor **112** of the sensor **14** may be configured to determine a disinfection condition of the sensor **14** by determining an amount of time that has elapsed since the sensor **14** was last disinfected and/or since the sensor **14** has been in use. For example, for embodiments in which the sensor **14** is disposable, the processor **112** may be configured to determine an amount of time that the sensor **14** has been in operation and to compare the amount of time to a predetermined threshold for sensor operation. The processor **112** may determine that the sensor **14** may correspond to the second disinfection condition, in which disposing of the sensor **14** may be desirable, in response to determining that the elapsed time exceeds the predetermined threshold. The sensor **14** may provide a user-perceivable indication, such as emitting light from one or more of the indicator lights **124**, in response to determining that the amount of time exceeds the predetermined threshold for sensor operation. This indication may alert the user that it may be desirable to dispose of the sensor **14**.

[0039] Additionally, for embodiments in which the sensor **14** is at least partially reusable, the processor **112** may be configured to determine an amount of time that has elapsed since the sensor **14** was last disinfected or an amount of time that the sensor **14** has been in use, if the sensor **14** has not been disinfected. Accordingly, as will be described in more detail below, the NV memory **108** may be configured to store information relating to prior disinfection processes, and the processor **112** may be configured to access the NV memory **108** to obtain time information for the last disinfection process, which may be used to determine when the sensor **14** was last disinfected. The processor **112** may compare the amount of time to a predetermined threshold for sensor operation, and may determine that the sensor **14** corresponds to the second disinfection condition, in which disinfecting the sensor **14** may be desirable, in response to determining that the elapsed time exceeds the predetermined threshold for sensor operation. In certain embodiments, the sensor **14** may provide a user-perceivable indication, such as emitting light from one or more of the indicator lights **124**, in response to determining that the amount of time exceeds the predetermined threshold for sensor operation. This indication may alert the user that it may be desirable to disinfect the sensor **14**.

[0040] As described above, the patient monitoring system **10** may be configured to determine a disinfection condition of the sensor **14** and to provide an indication to a user that it may be desirable to disinfect the sensor **14** when the disinfection condition of the sensor **14** exceeds a respective threshold. The present embodiments also provide various methods for providing an indication to disinfect the sensor **14** in accordance with the embodiments discussed above. For example, FIG. **3** illustrates an embodiment of a method **150** for providing an indication to disinfect reusable sensors **14** and for providing

an indication to dispose of single-use sensors **14**. Certain steps of the method **150** may be performed by a processor, or a processor-based device, such as the sensor **14** and/or the patient monitor **12**, which may each include instructions for implementing certain steps of the method **150**. Additionally, the instructions for implementing certain steps of the method **150** may be stored as coded instructions and/or algorithms in a memory device (e.g., the NV memory **108**, the RAM **70**, and/or the ROM **72**) and may be accessed and executed by a processor (e.g., the processor **112** and/or the processor **66**).

[0041] The method **150** includes operating the sensor **14** (block **152**). As described in detail above, operating the sensor (block **152**) may include driving the emitter **16** and detecting light after it has passed through the patient's tissue using the detector **18**. For embodiments in which the sensor **14** is at least partially reusable, the method **150** may include determining an elapsed time since the sensor **14** was last disinfected (block **154**). In certain embodiments, determining the elapsed time (block **154**) may include accessing the NV memory **108** to determine when the sensor **14** was last disinfected, which may be stored, for example, as a timestamp for a completed disinfection process. In other embodiments, a timestamp for the last disinfection process of the sensor **14** may be stored in the RAM **70** and/or the ROM **72** of the patient monitor **12**. The processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may compare the determined elapsed time to a predetermined time threshold to determine whether the elapsed time is less than the predetermined time threshold (block **156**). The predetermined time threshold may be a predetermined acceptable amount of time that the sensor **14** may operate before disinfection may be desirable. In certain embodiments, the predetermined time threshold may be between approximately 30 minutes and 48 hours, 1 hour and 36 hours, 2 hours and 24 hours, 3 hours and 12 hours, 4 hours and 10 hours, or any other time range. If the elapsed time is less than the predetermined time threshold, the method **150** may continue sensor operation (block **152**).

[0042] Alternatively, in response to determining that the elapsed time exceeds the predetermined time threshold, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to determine how many times the sensor **14** has been disinfected (block **158**). Certain reusable sensors **14** may have a maximum number of times they may be disinfected before it may be desirable to dispose of the sensor **14**. Accordingly, the method **150** may include determining whether the number of times the sensor **14** has been disinfected is less than a predetermined threshold for disinfections (block **160**). The predetermined threshold for disinfections may be between approximately 1 and 100 disinfections, 10 and 90 disinfections, 20 and 80 disinfections, 30 and 70 disinfections, 40 and 60 disinfections, or any other range. In response to determining that the number of times the sensor **14** has been disinfected is less than the predetermined threshold for disinfections, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may provide an indication to disinfect the sensor **14** (block **162**). The indication may be a visual indication, such as a symbol and/or a textual message on a display (e.g., the display **30** of the patient monitor **12** or a display of the sensor **14**), or a constant or flashing light (e.g., via the indicator lights **124**). The indication may also be an auditory indication, such as a beep. Further, in certain embodiments, the indication to disinfect the sensor **14** (block **162**) may be generated at a remote monitoring station. For example, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to transmit a signal to the remote monitoring station (e.g., via a central server), which may cause the remote monitoring station to provide the indication to disinfect the sensor **14** (block **162**).

[0043] Alternatively, if the number of times the sensor **14** has been disinfected is greater than the predetermined threshold for disinfections, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may provide an indication to dispose of the sensor **14** (block **164**). The indication may be a visual indication, such as a symbol and/or a textual message on a display (e.g., the display **30** of the patient monitor **12** or a display of the sensor **14**), or a constant or flashing light (e.g., via the indicator lights **124**). The indication may also be an auditory indication, such as a beep. Further, in certain embodiments, the indication to dispose of the sensor **14** (block **164**) may be generated at a remote monitoring station. For example, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to transmit a signal to the remote monitoring station (e.g., via a central server), which may cause the remote monitoring station to provide the indication to dispose of the sensor **14** (block **164**). Additionally, in certain embodiments, the indication to dispose of the sensor **14** (block **164**) may be provided as a different indication from the indication to disinfect the sensor **14** (block **162**). For example, in certain embodiments, the sensor **14** may include at least two indicator lights **124**, and the processor **112** may be configured to cause one of the indicator lights **124** to emit light (e.g., a first color) for the indication to disinfect the sensor **14** (block **162**) and may cause another of the indicator lights **124** to emit light (e.g., a second color) for the indication to dispose of the sensor **14** (block **164**). In one embodiment, a single indication light **124** may be utilized that may emit light of different colors.

[0044] In some embodiments, the method **150** may also include determining a measure of disinfection of the sensor **14** (block **166**). In certain embodiments, determining a measure of disinfection of the sensor **14** (block **166**) may include receiving one or more signals generated by the optical scanner **120** in response to scanning a colorant bacterial indicator disposed on the sensor body **46**. As described in detail above, the colorant bacterial indicator may be configured to undergo a color change in the presence of bacteria, which may be detected by the optical scanner **120**. In certain embodiments, the optical scanner **120** may determine the measure of disinfection and may transmit the measure of disinfection to the sensor **14** and/or the patient monitor **12**. In other embodiments, the optical scanner **120** may transmit a raw or a partially-processed signal to the sensor **14** and/or the patient monitor **12** for further processing and the calculation of the measure of disinfection. The processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may determine whether the measure of disinfection is less than a predetermined disinfection threshold (block **168**). If the elapsed time is less than the predetermined time threshold, the method **150** may continue sensor operation (block **152**). Alternatively, if the elapsed time exceeds the predetermined time threshold, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to determine whether the sensor **14** is reusable (block **170**). Determining whether the sensor is reusable (block **170**) may be desirable, because it may determine whether the provided indication should alert the user to disinfect or dispose of the sensor **14**. In some

embodiments, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may access and read stored information from the encoder **62** to determine whether the sensor **14** is reusable.

[0045] In response to determining that the sensor **14** is reusable, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may provide the indication to disinfect the sensor **14** (block **162**). Alternatively, if the sensor **14** is disposable, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to provide the indication to dispose of the sensor **14** (block **164**).

[0046] The method **150** may also include determining an elapsed time since the sensor **14** first began operating (block **172**). Determining the elapsed time since the sensor **14** first began operating (block **172**) may be desirable for disposable (e.g., single use) sensors **14**, which may have a maximum operating time before disposal may be desirable. In certain embodiments, determining the elapsed time since the sensor **14** first began operating (block **172**) may include accessing time data from the processor **112** and/or a clock (e.g., a real-time clock) of the sensor **14**. Accordingly, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to determine whether the elapsed time is less than a predetermined time threshold for sensor operation (block **174**). In certain embodiments, the predetermined time threshold may be between approximately 30 minutes and 48 hours, 1 hour and 36 hours, 2 hours and 24 hours, 3 hours and 12 hours, 4 hours and 10 hours, or any other time range. If the elapsed time is less than the predetermined time threshold, the method **150** may continue sensor operation (block **152**). In response to determining that the elapsed time is greater than the predetermined time threshold for sensor operation, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to provide the indication to dispose of the sensor **14** (block **164**).

[0047] Accordingly, when it is determined that it may be desirable to disinfect the sensor **14**, the sensor **14** may be provided to a disinfecting device. For example, FIG. **4** illustrates a disinfecting system **190** that may be used to disinfect the sensor **14**. As illustrated, the disinfecting system **190** includes a disinfecting unit **192** that may be configured to disinfect the sensor **14**. In certain embodiments, the disinfecting unit **192** may include one or more disinfecting devices **194**, which may be different types, such as, for example, an ultrasonic device **196**, a disinfecting solution device **198**, a disinfecting gas device **200**, an autoclave **202**, and a radiation (e.g., UV radiation and/or ionizing radiation) device **204**. However, it should be noted, that in certain embodiments, the disinfecting unit **192** may include one, two, three, four, or any number of disinfecting devices **194**. Additionally, the disinfecting system **190** may include any other suitable type of device for disinfecting the sensor **14**. Furthermore, while the disinfecting devices **194** are illustrated as disposed in a single housing **205** of the disinfecting unit **192**, in other embodiments, the disinfecting system **190** may include disinfecting devices **194** that are separate from one another (e.g., disposed in separate housings).

[0048] In certain embodiments, the sensor **14** may be manually placed into one or more of the disinfecting devices **194**. In one embodiment, the disinfecting unit **192** may be constructed as an automatic multi-stage disinfecting process in which the sensor **14** is transferred between disinfecting devices **194** (e.g., after the completion of a disinfection process in one disinfecting device **194**). By way of example, the disinfecting unit **192** may include a conveyor belt, and one or more of the walls of the disinfecting devices **194** may be configured to at least partially move and/or open to enable the sensor **14** to move between disinfecting devices **194**. However, in another embodiment, the disinfecting unit **192** may be constructed to enable more than one disinfecting process to occur within the housing **205**. That is, the disinfecting unit **192** may include components of two or more of the disinfecting devices **194**, and may be configured to implement at least two different disinfecting processes either simultaneously or in a predetermined order. In certain embodiments, the disinfecting unit **192** and/or each disinfecting device **194** may include a processor **206** configured to control the operation of the disinfecting unit **192** or the disinfecting device **194**, respectively.

[0049] Regardless of the type or number of disinfecting devices **194** that are utilized to disinfect the sensor **14**, it may be desirable to determine whether the sensor **14** has been disinfected, what type of disinfecting device **194** (or disinfecting devices **194**) were utilized to disinfect the sensor **14**, and/or whether the disinfecting processes implemented by the one or more disinfecting devices **194** were successful (e.g., if the parameters for the disinfecting processes were within an acceptable range to enable disinfection of the sensor **14**). Indeed, as noted above, the processor **112** of the sensor **14** may utilize signals generated by the additional sensors **48** to monitor changes in a condition (e.g., temperature, pressure, moisture, etc.) of the sensor **14** during one or more disinfection processes, which may provide information regarding the type of disinfection devices **194** utilized, the duration of time the sensor **14** was exposed to each disinfecting process, and/or the quality of each disinfection process (e.g., successful or faulty). Specifically, the one or more additional sensors **48** may generate signals, or combinations of signals, which may be identified by the processor **112** as corresponding to a particular disinfecting process. By way of example, the sensor **14** may include a temperature sensor and a pressure sensor, which may provide signals to the processor **112** indicating that the sensor **14** was exposed to high temperatures and high pressures, and the processor **112** may determine that the sensor **14** was disinfected using an autoclave. Various embodiments of the additional sensors **48** will be described in detail below and, in particular, will be discussed in combination with various types of the disinfecting devices **194**.

[0050] The one or more signals from the additional sensors **48** and/or any information determined by the processor **112** based upon the one or more signals may be stored in the NV memory **108**. The NV memory **108** and/or the encoder **62**, if utilized, may also be configured to store predetermined thresholds for one or more parameters (e.g., pressure, temperature, moisture, time) for one or more disinfecting processes (e.g., ultrasonic cleaning, exposure to a disinfecting solution and/or gas, autoclaving, exposure to radiation). As will be described in more detail below with respect to FIG. **5**, the predetermined thresholds may be utilized by the processor **112** to determine whether a particular disinfecting process may have been successful in disinfecting the sensor **14**. The various predetermined thresholds will be described below with respect to their corresponding disinfecting processes. Further, it should be noted that the predetermined threshold may vary based upon a particular sensor type (e.g., clip-style sensor, adhesive sensor, adult sensor, pediatric sensor, neonatal sensor, etc.).

[0051] However, in addition to the additional sensors **48**, the sensor **14** may also be configured to receive wireless signals via the transceiver **20**, which may provide information for determining whether the sensor **14** was disinfected and/or what type of disinfecting devices **194** were utilized to disinfect the sensor **14**. In particular, the disinfecting unit **192** may include at least one transceiver **208**, which may be configured to establish wireless communication with the transceiver **20** using any suitable protocol. In some embodiments, each disinfecting device **194** of the disinfecting unit may include the transceiver **208**. In some embodiments, the sensor **14** may be configured to transmit an interrogation signal via the transceiver **20**, which may be received by the one or more transceivers **208** when the sensor **14** is in operational proximity of the respective disinfecting device **194**. As used herein, operation proximity is defined as a distance between the transceiver **20** of the sensor **14** and the transceiver **206** of one of the disinfecting devices **194** that enables wireless signals to be transmitted and received between the transceiver **20** and the transceiver **208**. Additionally, the one or more transceivers **208** may each transmit a confirmation signal to the sensor **14** in response to receiving the interrogation signal. In other embodiments, the one or more transceivers **208** may be configured to at least periodically transmit interrogation signals to the sensor **14**, which may be received by the transceiver **20** when the sensor **14** is in operational proximity to the respective disinfecting device **194**. In certain embodiments, the processor **112** may be configured to determine that the sensor **14** is disposed within one of the disinfecting devices **194** based at least in part upon a received signal from the transceiver **208** of the respective disinfecting device **194**. In some embodiments, the transceiver **208** may also transmit one or more signals to the sensor **14** indicating that the disinfecting device **194** is disinfecting the sensor **14** and/or that the disinfecting device **194** has completed the disinfecting process for disinfecting the sensor **14**. This may be advantageous to minimize any false determinations of a completed disinfection by the sensor **14**, which may occur, for example, if the sensor **14** is placed in the disinfecting unit **192** without operating the disinfecting unit **192**.

[0052] Additionally or alternatively, the sensor **14** may include a radio-frequency identification (RFID) tag **210**. The RFID tag **210** may be an active tag, which may transmit radio-frequency signals to an RFID antenna unit (e.g., an RFID antenna unit **212** of the disinfecting unit **192**). Alternatively, the RFID tag **210** may be a passive tag, which may be activated and powered by a signal transmitted from the RFID antenna unit (e.g., the RFID antenna unit **212**). In some embodiments, the disinfecting unit **192** may include the RFID antenna unit **212** in each disinfecting device **194**. This may be advantageous, because the RFID antenna units **212** may detect the RFID tag **210** (e.g., may "read" the sensor **14**) in each disinfecting unit **194**. In this manner, the sensor **14** may be tracked through each stage of the disinfecting unit **192**. In certain embodiments, the disinfecting unit **192** may be configured to store information related to the tracking of the sensor **14** in a memory device (not shown). Additionally, the disinfecting unit **192** may be configured to transmit the information relating to the tracking to the sensor **14** and/or a remote device (e.g., the patient monitor **12** and/or a remote monitoring station). The disinfecting unit **192** may be configured to transmit the information wirelessly and/or through a wired connection.

[0053] As noted above, the disinfecting unit **192** may include the ultrasonic device **196**. The ultrasonic device **196** may include a transducer **214** configured to generate ultrasonic waves through a liquid (e.g., water, a cleaning solvent, or a disinfecting solution) disposed in the ultrasonic device **196**. The ultrasonic device **196** may be desirable to loosen and/or remove debris from the sensor **14**. In certain embodiments, the minimum predetermined time threshold for exposure to the ultrasonic waves may be between approximately 1 second to 10 minutes, 5 seconds to 5 minutes, 10 seconds to 3 minutes, 20 seconds to 2 minutes, or any suitable time range. As illustrated, the sensor **14** may include the one or more additional sensors **48**, which may include an ultrasonic pressure sensor **216** configured to detect the ultrasonic waves.

[0054] The disinfecting unit **192** may also include the disinfecting solution device **198**. The disinfecting solution device **198** may utilize any suitable solution or combinations of solutions for disinfecting the sensor **14**, such as alcohols, aldehydes, phenolics, halogens, heavy metals, surface active agents, and/or dyes. In certain embodiments, the disinfecting solution device **198** may utilize a solution of approximately 70 percent isopropyl alcohol and/or a 1:10 bleach solution. The disinfection solution device **198** may be filled with one or more disinfecting solutions either manually or automatically. Additionally or alternatively, the disinfection solution device **198** may include one or more sprayers **218** configured to spray the one or more disinfecting solutions on the sensor **14**. In certain embodiments, the minimum predetermined time threshold for exposure to the disinfecting solution may be between approximately 1 minute and 2 hours, 5 minutes and 1.5 hours, 10 minutes and 1 hour, 20 minutes and 45 minutes, or any other time range. As illustrated, the sensor **14** may include the one or more additional sensors **48**, which may include a moisture sensor **220** configured to detect exposure to a disinfecting solution and/or a pressure sensor **222** configured to detect pressure changes from contact due to the disinfecting solution (e.g., from the sprayers **218**).

[0055] In certain embodiments, the disinfecting unit **192** may also include the disinfecting gas device **200**. The disinfecting gas device **200** may utilize any suitable gas or combination of gases for disinfecting the sensor **14**. For example, the disinfecting gas device **200** may utilize formaldehyde, plasma, chlorine dioxide, and/or ethylene oxide. The disinfecting gas device **200** may include one or more valves (not shown) to enable the one or more disinfecting gases to enter the disinfecting gas device **200** (e.g., from a reservoir). In some embodiments, the disinfecting gas device **200** may also include one or more sprayers **226** configured to spray the disinfecting gas on the sensor **14**. Additionally, in one embodiment, the disinfecting gas device **200** may include one or more aerators (not shown). The one or more aerators may be utilized to dissipate any remaining disinfecting gas from the sensor **14** and may be particularly advantageous when utilizing ethylene oxide. In certain embodiments, the sensor **14** may include the pressure sensor **222**, which may be configured to detect pressure changes from contact due to the disinfecting gas (e.g., from the sprayers **226**). In one embodiment, the sensor **14** may include one or more gas sensors (not shown) configured to detect one or more types of gas.

[0056] Additionally, in certain embodiments, the disinfecting gas device **200** may also be configured for dry heat sterilization. For example, the disinfecting gas device **200** may include a heat source **230** to provide heat to the disinfecting gas device **200**. Additionally, in one embodiment, the disin-

fecting gas device **200** may be configured to utilize air, rather than a disinfecting gas, in combination with the heat source **230** to implement a dry heat sterilization process. In certain embodiments, the minimum predetermined temperature threshold may be between approximately 10 degrees Celsius and 300 degrees Celsius, 50 degrees Celsius and 250 degrees Celsius, 100 degrees Celsius and 200 degrees Celsius, or 150 degrees Celsius and 180 degrees Celsius, or any other temperature range. Additionally, the minimum predetermined time threshold for exposure to the disinfecting gas and/or the heat may be between approximately 30 minutes and 3 hours, 45 minutes and 2.5 hours, 1 hour and 2 hour, or any other time range. Accordingly, in certain embodiments, the sensor **14** may include the one or more additional sensors **48**, which may include a temperature sensor **232** configured to determine a temperature the sensor **14** is exposed to in the disinfecting gas device **200**.

[0057] The disinfecting unit **192** may also include the autoclave **202** to disinfect the sensor **14**. The autoclave **202** may be configured to provide steam at a high temperature and a high pressure. The minimum predetermined pressure threshold may be between approximately 30 kilopascals (kPa) to 280 kPa, 70 kPa to 210 kPa, 100 kPa to 170 kPa, or any other suitable pressure range. The minimum predetermined temperature threshold may be between approximately 100 degrees Celsius and 200 degrees Celsius, 110 degrees Celsius and 190 degrees Celsius, 120 degrees Celsius and 180 degrees Celsius, or any other suitable temperature range. Additionally, the minimum predetermined threshold for the period of time that the sensor **14** is exposed to the temperature and pressure may be between approximately 1 minute and 1 hour, 5 minutes and 50 minutes, 10 minutes and 40 minutes, 15 minutes and 30 minutes, or any other suitable range. In certain embodiments, the sensor **14** may include the pressure sensor **222** and the temperature sensor **232** to detect pressures and temperatures the sensor **14** is exposed to in the autoclave **202**, respectively.

[0058] Additionally, in one embodiment, the disinfecting unit **192** may include the radiation device **204**. The radiation device **204** may include a radiation source **234**, which may be configured to direct radiation on the sensor **14** when the sensor **14** is disposed in the radiation device **204**. In certain embodiments, the radiation source **234** may be configured to emit ultraviolet (UV) radiation and/or ionizing radiation, such as, for example, cathode rays, X-rays, electron-rays, and/or gamma-rays. The minimum predetermined time threshold for exposure to the radiation source **234** may be between approximately 1 second and 5 minutes, 5 seconds and 4 minutes, 10 seconds and 3 minutes, 20 seconds and 2 minutes, 30 seconds and 1 minute, or any other time range. In certain embodiments, the sensor **14** may include the additional sensors **48**, which may include a semiconductor **236** (e.g., a silicon diode or a photodiode) configured to detect ionizing radiation. The semiconductor **236** may also be configured to detect UV radiation.

[0059] As described above, the processor **112** of the sensor **14** may be configured to receive signals from the additional sensors **48** (e.g., the ultrasonic pressure sensor **216**, the moisture sensor **220**, the pressure sensor **222**, the temperature sensor **232**, the semiconductor **236**, and any other suitable sensor), signals from the transceiver **20** that may be transmitted from the transceiver **208** of the disinfecting unit **192**, and/or signals from the RFID tag **210** and/or the RFID antenna unit **212**. Based at least in part upon the received signals, the processor **112** may be configured to determine whether the sensor **14** was disinfected and/or which disinfecting device **194** or disinfecting devices **194** were utilized to disinfect the sensor **14**. As will be described in detail below with respect to FIG. **5**, the processor **112** may also utilize the signals to determine whether the disinfection processes met or exceeded minimum predetermined thresholds (e.g., to determine the quality of the disinfection processes). In some embodiments, the processor **112** may cause the sensor **14** to provide one or more user-perceivable indications of the disinfection process (or disinfection processes). By way of example, the processor **112** may cause one of the indicator lights **124** to emit light in response to determining that the sensor **14** has been disinfected and is ready for use and may cause another of the indicator lights **124** to emit light in response to determining that the disinfecting process utilized did not meet a minimum predetermined threshold. Additionally, the sensor **14** may be configured to store information relating to the disinfecting in the NV memory **108**. This stored information may be transmitted to an external device (e.g., the patient monitor **12**, the disinfecting unit **192**, a remote monitoring station, or any other suitable device) via the transceiver **20** or a wired connection (e.g., the cable **24**).

[0060] To determine quality information for the disinfection processes, the processor **112** may be configured to compare the one or more signals received from the additional sensors **48** to their respective minimum predetermined thresholds for each disinfection process, as described in detail above. In particular, the processor **112** may determine that the sensor **14** was properly disinfected if each relevant parameter (e.g., pressure, temperature, time, moisture, etc.) for a particular disinfection process (e.g., autoclaving, dry-heat sterilization, exposure to a disinfecting solution, exposure to a disinfecting gas, ultrasonic cleaning, exposure to UV and/or ionizing rays) is within an acceptable range for the given parameter (e.g., above the respective minimum predetermined threshold). For example, FIG. **5** illustrates an embodiment of a method **250** for providing an indication of a successful disinfection process utilized to disinfect the sensor **14**. Certain steps of the method **250** may be performed by a processor, or a processor-based device, such as the sensor **14** and/or the patient monitor **12**, which may each include instructions for implementing certain steps of the method **250**. Additionally, the instructions for implementing certain steps of the method **250** may be stored as coded instructions and/or algorithms in a memory device (e.g., the NV memory **108**, the RAM **70**, and/or the ROM **72**) and may be accessed and executed by a processor (e.g., the processor **112** and/or the processor **66**).

[0061] The method **250** may include receiving one or more signals from one or more sensors (e.g., the additional sensors **48**) disposed in or on a medical sensor (e.g., the sensor **14**) exposed to a disinfection process (block **252**). As described in detail above, the additional sensors **48** may include the ultrasonic pressure sensor **216**, the moisture sensor **220**, the pressure sensor **222**, the temperature sensor **224**, the semiconductor **234**, and any other suitable sensor. The method **250** may also include receiving one or more signals from a disinfecting device (e.g., the disinfecting unit **192**) implementing the disinfection process (block **254**). As described in detail above, the one or more signals may be transmitted from the transceiver **208** of the disinfecting unit **192**, which may inform the processor **112** that the sensor **14** is disposed in and/or is being disinfecting by one of the disinfecting devices **194** of the

disinfecting unit **192**. In some embodiments, the one or more signals may provide information to the processor **112** regarding the particular disinfecting process utilized. Additionally, the one or more signals may be generated by the RFID antenna unit **212** and transmitted to the sensor **14**, which may provide information to the processor **112** regarding the tracking of the sensor **14** through the disinfecting devices **194** of the disinfecting unit **192**.

[0062] The method **250** may include determining one or more parameters of the disinfection process based at least in part upon the received signals from the additional sensors **48** and/or the disinfecting unit **192** (block **256**). As described in detail above, the one or more parameters may include pressure, temperature, time, and/or exposure to a disinfecting solution, a disinfecting gas, UV radiation, ionizing radiation, and/or ultrasonic waves. The processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to determine the type of disinfection process (block **258**) based at least in part upon the received signals from the additional sensors **48**, the received signals from the disinfecting unit **192**, and/or the determined parameters of the disinfection process. As described in detail above, the sensor **14** may have a different minimum predetermined threshold, which may be dependent upon the disinfection processes utilized to disinfect the sensor **14**. Accordingly, it may be desirable to determine the disinfection process utilized to disinfect the sensor **14** to select the appropriate minimum predetermined threshold or thresholds.

[0063] Accordingly, the method **250** may include determining whether one or more determined parameters of the determined disinfection process are each above their respective minimum predetermined thresholds (block **260**). In particular, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may be configured to access the minimum predetermined thresholds stored in the NV memory **108**, as described in detail above with respect to FIG. **4**. The processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may determine that the sensor **14** has been disinfected properly and may provide a user-perceivable indication of a successful disinfection process (block **262**) in response to determining that the one or more determined parameters of the determined disinfection process are greater than or equal to the respective minimum predetermined thresholds. In one embodiment, the sensor **14** may be configured to provide the user-perceivable indication of a successful disinfection process (block **262**), which may be an audible indication or a visual indication. For example, the processor **112** may cause one of the one or more indicator lights **124** to emit light. Additionally, in response to determining that one or more of the determined parameters are not above their respective minimum predetermined thresholds, the processor-based device (e.g., the sensor **14** and/or the patient monitor **12**) may provide a user-perceivable indication of an unsuccessful disinfection process (block **264**). In certain embodiments, the processor **112** may cause another of the indicator lights **124** to emit light, which may be of a different color than the indicator light **124** that is emitted when the processor **112** determines that the disinfection process was successful. In one embodiment, a single indicator light **124** may be configured to emit multiple colors. The user-perceivable indication of the unsuccessful disinfection process (block **264**) may be provided as an alarm, which may be an audible alarm, such as a beep, and/or a textual alarm, such as an error message.

[0064] As noted above, monitoring the disinfection status of the sensor **14** and monitoring one or more changes in a condition of the sensor **14** during a disinfection process may increase the power consumption of the sensor **14**. As a result, for embodiments in which the sensor **14** utilizes the battery **44** as a power source, problems may exist in which the battery **44** may drain, and the battery **44** must be recharged or replaced to continue sensor operation. Additionally, as noted above, the sensor **14** may be configured to operate using both power from the battery **44** and wired power (e.g., via the cable **24**) from a charging device. In particular, the sensor **14** may operate using wired power when the sensor **14** is coupled to a charging device via the cable **24** and may operate using battery power when the sensor **14** is not coupled to a charging device. Accordingly, to minimize battery drainage, it may be desirable to minimize battery use and operate using wired power when the sensor **14** is within range of a charging device. Unfortunately, the user and/or the patient may forget to attach the sensor **14** to the cable (e.g., the cable **24**) of the charging device when the sensor **14** is within range of the charging device.

[0065] To address this issue, the present embodiments describe techniques to detect when the sensor **14** is within a predetermined range of a charging device (e.g., the sensor **14** is located less than a minimum predetermined distance from the charging device) and to provide an indication to a user that the sensor **14** is within the predetermined range. As used herein, the sensor **14** may be in proximity to a charging device, if the sensor **14** is within the predetermined range of the charging device. For example, FIG. **6** illustrates a block diagram of a system **280** that may include the sensor **14** and a charging device **282** for providing power to the sensor **14** when the sensor **14** is physically coupled to the charging device **282**. As illustrated, the patient monitor **12** may include the charging device **282**. However, in other embodiments, the charging device **282** may also be a device separate from the patient monitor **12**. Additionally, while some of the components of the patient monitor **12** and the sensor **14** are not illustrated, it should be noted that the patient monitor **12** and/or the sensor **14** may also include one or more of their respective components as described above with respect to FIG. **2**.

[0066] The charging device **282** may include a power source **284** configured to provide power to the sensor **14**. In certain embodiments, the power source **284** may be configured to provide power for recharging the battery **44** of the sensor **14**. The power source **284** may be any suitable power source, such as, for example, a battery, a rechargeable battery, and/or an energy harvesting power supply (e.g., a motion generated energy harvesting device, thermoelectric generated energy harvesting device, or a similar device). Additionally, in some embodiments, the power source **284** may include a power adaptor that is configured to receive power from an external power source **286**. The external power source **286** may be an AC power source, a battery, a rechargeable battery, an energy harvesting power supply (e.g., a motion generated energy harvesting device, thermoelectric generated energy harvesting device, or a similar device), and/or any other suitable power source.

[0067] The charging device **282** may also include a charging control circuit **288**. The charging control circuit **288** may, for example, enable the adaptive control of the power source **284** and/or the power source **286** for providing power to the sensor **14**. In certain embodiments, the charging control cir-

cuit **288** may also enable or facilitate the determination that the sensor **14** is in proximity to the charging device **282**. The charging control circuit **288** may include, for example, a processing circuit and a transceiver **290**. In one embodiment, the processing circuit may include the processor **66** of the patient monitor **12**. In another embodiment, the processing circuit may be a separate processor from the processor **66**. Additionally, in one embodiment, the transceiver **290** may include the transceiver **22** of the patient monitor **12**. However, as illustrated, the transceiver **290** may be a separate transceiver from the transceiver **22**.

[0068] As described above, the sensor **14** may include the one or more additional sensors **48**, which may include a proximity detector **292**. The proximity detector **292** may include any suitable components for generating information relating to the proximity of the sensor **14** to the charging device **282**. By way of example, the proximity detector **292** may include an infrared (IR) sensor, a capacitive photoelectric sensor, an inductive proximity sensor, a Doppler velocimeter, an ultrasonic sensor, or any other suitable sensor. In one embodiment, the proximity detector **292** may include a short range transceiver **294**. The transceiver **294** may be configured to at least periodically transmit signals to and/or receive signals from the transceiver **290**. Accordingly, in certain embodiments, the transceiver **290** may also be a short range transceiver. The transceiver **290** and the transceiver **294** may be configured to wirelessly transmit data using any suitable wireless standard, such as the IEEE 802.15.4 standard, the Bluetooth standard, one or more of the IEEE 802.11 standards, an ultra-wideband (UWB) standard, or a near-field communication (NFC) standard. In one embodiment, the transceiver **290** and the transceiver **294** may be configured to transmit and/or receive radio-frequency signals.

[0069] In some embodiments, the transceiver **294** of the sensor **14** may be configured to transmit signals to the transceiver **290** of the charging device **282**, and the charging control circuit **288** (e.g., the processor **66**) may be configured to determine that the sensor **14** is in proximity to the charging device **282** if the signals are received by the transceiver **290**. In other embodiments, the transceiver **290** of the charging device **282** may transmit signals to the transceiver **294** of the sensor **14**, and the processor **112** of the sensor **14** (or another processor or data processing circuitry) may be configured to determine that the sensor **14** is in proximity to the charging device **282** if the signals are received by the transceiver **294**. Further, in another embodiment, the transceiver **294** of the sensor **14** may transmit signals to the transceiver **290** of the charging device **282**, which, if received by the transceiver **290**, may activate the transceiver **290** and cause the transceiver **290** to transmit a confirmation signal to the transceiver **294**. In such an embodiment, the processor **112** of the sensor **14** may determine that the sensor **14** is in proximity to the sensor **14** in response to receiving the confirmation signal. Additionally, the transceiver **290** and the transceiver **294** may be configured such that signals transmitted from the transceiver **290** or the transceiver **294** may be received by the transceiver **294** and the transceiver **290**, respectively, when the transceiver **290** and the transceiver **294** are within a minimum predetermined distance from the other. For example, the minimum predetermined distance may be between approximately 10 centimeters and 20 meters, 20 centimeters and 15 meters, 30 centimeters and 10 meters, 40 centimeters and 5 meters, 50 centimeters and 4 meters, 60 centimeters and 3 meters, 70 centimeters and 2 meters, or any other suitable range.

[0070] In certain scenarios, a weak signal may be received by the transceiver **290** or the transceiver **294** even though the sensor **14** may be located at a distance from the charging device **282** that is greater than the minimum predetermined distance. Accordingly, in some embodiments, it may also be desirable to determine the signal strength of the received signal and to compare the signal strength to a minimum predetermined threshold for signal strength that may indicate that the sensor **14** is in proximity to the charging device **282**. The minimum predetermined threshold for signal strength may be empirically determined such that the minimum predetermined threshold for signal strength approximately corresponds to a particular distance between the sensor **14** and the charging device **282**. The minimum predetermined threshold for signal strength may be between approximately 0 percent and 100 percent, 20 percent and 95 percent, 40 percent and 90 percent, 60 percent and 85 percent, or any other range. Accordingly, the charging control circuit **288** and/or the processor **112** may be configured to determine the signal strength of the signal received by the transceiver **290** or the transceiver **294**, respectively, and may compare the signal strength to the minimum predetermined threshold for signal strength. The charging control circuit **288** and/or the processor **112** may determine that the sensor **14** is in proximity to the charging device **282** if the signal strength is greater than the minimum predetermined threshold for signal strength. Alternatively, if the signal strength is less than the minimum predetermined threshold for signal strength, the charging control circuit **288** and/or the processor **112** may determine that the sensor **14** is not in proximity to the charging device **282**.

[0071] In another embodiment, the proximity detector **292** may include one or more magnetic field generators **296**. In certain embodiments, the magnetic field generator **296** may be configured to produce oscillations (e.g., pulses) such that the magnetic field generator **296** is periodically generating a magnetic field (e.g., magnetic proximity signals). Alternatively, the magnetic field generator **296** may continuously generate a magnetic field. In some embodiments, the magnetic field generator **296** may be configured to generate a magnetic proximity signal having a predetermined signal strength. Accordingly, the charging device **282** may include one or more magnetic field sensors **298** configured to detect magnetic proximity signals. It should be noted, however, that in other embodiments, the sensor **14** may include the magnetic field sensor **298** and the charging device **282** may include the magnetic field generator **296**. The charging control circuit **288** may be configured to receive signals from the magnetic field sensor **298** when the magnetic field sensor **298** detects one or more magnetic proximity signals. The charging control circuit **288** may also be configured to determine a signal strength of the received signals and to compare the determined signal strength to a minimum predetermined threshold for signal strength, which may be at least partially dependent upon the predetermined signal strength of the transmitted magnetic proximity signal. The charging control circuit **288** may determine that the sensor **14** is in proximity to the charging device **282** if the signal strength is greater than the minimum predetermined threshold for signal strength. Alternatively, if the signal strength is less than the minimum predetermined threshold for signal strength, the charging

control circuit **288** may determine that the sensor **14** is not in proximity to the charging device **282**.

[0072] Regardless of the method used to determine whether the sensor **14** is in proximity to the charging device **282**, the sensor **14** and/or the charging device **282** may be configured to provide a user-perceivable indication of the proximity of the sensor **14** to the charging device **282**. The user-perceivable indication may alert the user that the sensor **14** may be coupled to the charging device **282** to receive power from the charging device **282**. The user-perceivable indication may be a visual indication and/or an audible indication. For example, the processor **112** of the sensor **14** may cause one of the indicator lights **124** to emit light and/or flash. In some embodiments, the patient monitor **12** and/or the multi-parameter monitor **34** may be configured to provide a visual indication (e.g., a symbol, a graphical indication, and/or a textual message) on the display **30** and/or the display **40**, respectively. In one embodiment, the sensor **14** may also include a display (not shown), such as an electronic paper display (e.g., an electronic ink (E-ink) display), which may be configured to display the indication. Additionally, the sensor **14** may include a speaker **300** to provide an audible indication, such as a beep and/or an alarm. The patient monitor **12** may also provide the audible indication via the speaker **74**. Further, in some embodiments, the sensor **14** and/or the patient monitor **12** may transmit a signal (e.g., via a central network) to a pager **302** (e.g. a pager of a caregiver), which may cause the pager **302** to provide the user-perceivable indication, which may be visual, audible, and/or tactile (e.g., a vibration).

[0073] In some embodiments, it may be desirable to delay the user-perceivable indication for a predetermined period of time, for example, to reduce nuisance alarms on the pager **302**. In certain embodiments, the predetermined period of time may be based at least in part upon a level of charge of the battery **44**. For example, if the level of charge of the battery **44** is greater than a predetermined charge threshold, the predetermined period of time may be longer than a given predetermined period of time when the level of charge of the battery **44** is less than the predetermined charge threshold. The predetermined charge threshold of the battery **44** may be, for example, between approximately 0 percent and 70 percent, 5 percent and 60 percent, 10 percent and 50 percent, or 15 percent and 40 percent of the total charge level of the battery **44**. However, any other suitable charge threshold may be utilized. Similarly, it may be desirable to provide additional user-perceivable indications and/or increase the nuisance or annoyance of the user-perceivable indication if the level of charge of the battery **44** is less than a minimum predetermined charge threshold. For example, the user (e.g., the patient or the caregiver) may not couple the sensor **14** to the charging device **282** in response to a first user-perceivable indication. Thus, it may be desirable to provide a second user-perceivable indication and/or to increase the severity of the first user-perceivable indication (e.g., a louder alarm or flashing indicator light **124**) after a predetermined period of time and/or after the level of charge of the battery **44** is less than a minimum predetermined charge threshold.

[0074] For example, FIG. **7** illustrates an embodiment of a method **320** for providing indications to couple a sensor (e.g., the sensor **14**) to a charging device (e.g., the charging device **282**). Certain steps of the method **320** may be performed by a processor, or a processor-based device, such as the sensor **14**, the patient monitor **12**, and/or the charging device **282**, which may each include instructions for implementing certain steps of the method **320**. Additionally, the instructions for implementing certain steps of the method **320** may be stored as coded instructions and/or algorithms in a memory device (e.g., the NV memory **108**, the RAM **70**, and/or the ROM **72**) and may be accessed and executed by a processor (e.g., the processor **112**, the processor **66**, the charging control circuit **288**). The method **320** may be implemented with a single user-perceivable indicator or multiple user-perceivable indicators.

[0075] The method **320** may include operating a sensor (e.g., the sensor **14**) (block **322**). The method **320** may also include determining whether the sensor **14** is operating on battery power (e.g., operating in a wireless mode) (block **324**). If the sensor **14** is not operating on battery power (e.g., is operating on power received from a charging device or operating in a wired mode), the method **320** may continue sensor operation (block **322**). Alternatively, if the processor-based device (e.g., the sensor **14**, the patient monitor **12**, and/or the charging device **282**) determines that the sensor **14** is operating on battery power, the processor-based device may determine whether the sensor **14** is within a predetermined range of a charging device (e.g., the charging device **282**) (block **326**). Determining whether the sensor **14** is within a predetermined range of the charging device **282** may include utilizing signals from the proximity detector **292**, as described above with respect to FIG. **6**, to determine whether the sensor **14** is located less than a predetermined distance from the charging device **282**. If the sensor **14** is not within the predetermined range of the charging device **282**, the method **320** may continue sensor operation (block **322**). Alternatively, if the processor-based device (e.g., the sensor **14**, the patient monitor **12**, and/or the charging device **282**) determines that the sensor **14** is within the predetermined range of the charging device **282**, the processor-based device may provide a first indication to couple the sensor **14** to the charging device **282** (block **328**). As described above, the first indication may be a visual and/or an audible user-perceivable indication. For example, the sensor **14** may cause one or more of the indicator lights **124** to emit light. The sensor **14** may also be configured to emit an audible indication via the speaker **300**. In certain embodiments, the first indication to couple the sensor **14** to the charging device **282** (block **328**) may be continuously or periodically provided until the sensor **14** is coupled to the charging device **282**. Alternatively, the first indication to couple the sensor **14** to the charging device **282** (block **328**) may be provided only once.

[0076] The method **320** may also include setting a timer (block **330**). After the timer has been set (block **330**), the method **320** may include determining whether the sensor **14** has been coupled to the charging device **282** (block **332**). In certain embodiments, the sensor **14** may determine that the sensor **14** is coupled to the charging device **282** if the sensor **14** detects received power. In response to determining that the sensor **14** is coupled to the charging device **282**, the processor-based device (e.g., the sensor **14**, the patient monitor **12**, and/or the charging device **282**) may cancel the timer (block **334**) and may continue sensor operation (block **322**). If the processor-based device (e.g., the sensor **14**, the patient monitor **12**, and/or the charging device **282**) determines that the sensor **14** is not coupled to the charging device **282**, the timer may continue to run. The method **320** may include determining whether the timer has expired (block **336**). If the timer has

not expired, the method **320** may continue determining whether the sensor **14** is coupled to the charging device **282** (block **332**).

[0077] However, if the timer expires, the processor-based device (e.g., the sensor **14**, the patient monitor **12**, and/or the charging device **282**) may provide a second indication to couple the sensor **14** to the charging device **282** (block **338**). In certain embodiments, the second indication (block **338**) may be different than the first indication (block **328**). In particular, providing the second indication (block **338**) may include escalating a property of the first indication (block **328**). For example, where the first indication (block **328**) was provided as an audible tone, the second indication (block **338**) may be provided as an audible tone with a higher frequency and/or a higher volume. In another embodiment, the harmonic content of the audible tone may change for the second indication (block **338**). Additionally or alternatively, where the first indication (block **328**) included emitting one of the indicator lights **124**, the second indication (block **338**) may include flashing the indicator light **124** and/or emitting another of the indicator lights **124**. In some embodiments, the first indication (block **328**) may be provided by the sensor **14**, and the second indication (block **338**) may be provided by the patient monitor **12**, the multi-parameter monitor **34**, the charging device **282**, and/or the pager **302**. Additionally, if the timer has expired, the timer may be reset with a reduced period (e.g., half of the initial timer period) (block **340**). In some embodiments, this procedure continues as each successive timer expires, thus gradually increasing the annoyance level of the second indication (block **338**), which may be desirable in some embodiments to alert a user to couple the sensor **14** to the charging device **282**.

[0078] The disclosed embodiments may be interfaced to and controlled by a computer readable storage medium having stored thereon a computer program. The computer readable storage medium may include a plurality of components such as one or more of electronic components, hardware components, and/or computer software components. These components may include one or more computer readable storage media that generally store instructions such as software, firmware and/or assembly language for performing one or more portions of one or more implementations or embodiments of an algorithm as discussed herein. These computer readable storage media are generally non-transitory and/or tangible. Examples of such a computer readable storage medium include a recordable data storage medium of a computer and/or storage device. The computer readable storage media may employ, for example, one or more of a magnetic, electrical, optical, biological, and/or atomic data storage medium. Further, such media may take the form of, for example, floppy disks, magnetic tapes, CD-ROMs, DVD-ROMs, hard disk drives, and/or solid-state or electronic memory. Other forms of non-transitory and/or tangible computer readable storage media not list may be employed with the disclosed embodiments.

[0079] A number of such components can be combined or divided in an implementation of a system. Further, such components may include a set and/or series of computer instructions written in or implemented with any of a number of programming languages, as will be appreciated by those skilled in the art. In addition, other forms of computer readable media such as a carrier wave may be employed to embody a computer data signal representing a sequence of instructions that when executed by one or more computers causes the one or more computers to perform one or more portions of one or more implementations or embodiments of a sequence.

[0080] While the disclosure may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the embodiments provided herein are not intended to be limited to the particular forms disclosed. Rather, the various embodiments may cover all modifications, equivalents, and alternatives falling within the spirit and scope of the disclosure as defined by the following appended claims

What is claimed is:

1. A sensor configured to operate in a wireless mode or in a wired mode, comprising:

one or more sensing components configured to measure a physiological signal of a patient;

a transceiver configured to wirelessly transmit the physiological signal at least when the sensor is operating in the wireless mode;

a power source configured to power the one or more sensing components and the transceiver at least when the sensor is operating in the wireless mode;

a connector configured to receive a cable, wherein the cable is configured to couple to a charging device configured to provide power to the one or more sensing components of the sensor or to recharge the power source of the sensor, and wherein the sensor is configured to operate in the wired mode when the connector is coupled to the cable; and

a proximity detector configured to generate one or more signals relating to a distance between the sensor and the charging device.

2. The sensor of claim **1**, wherein the sensor comprises processing circuitry configured to receive the one or more signals from the proximity detector and to determine whether the sensor is located within a predetermined distance of the charging device based at least in part upon the one or more signals.

3. The sensor of claim **2**, wherein the processing circuitry is configured to provide a user-perceivable indication via a first indicator in response to determining that the sensor is located within the predetermined distance of the charging device and that the sensor is operating in the wireless mode.

4. The sensor of claim **3**, wherein the sensor comprises one or more indicator lights, and wherein the processing circuitry is configured to cause one of the one or more indicator lights to emit light to provide the user-perceivable indication.

5. The sensor of claim **3**, wherein the processing circuitry is configured to determine whether the sensor is coupled to the charging device within a predetermined period of time after the user-perceivable indication is provided, and wherein the processing circuitry is configured to provide a second user-perceivable indication via the first indicator or a via a second indicator in response to determining that the sensor was not coupled to the charging device within the predetermined period of time.

6. The sensor of claim **1**, wherein the proximity detector comprises a short range transceiver configured to wirelessly communicate with a short range transceiver of the charging device.

7. The sensor of claim **1**, wherein the sensor comprises a pulse oximetry sensor.

8. A method for providing indications to charge a medical sensor, comprising:

determining whether the medical sensor is operating in a wireless mode;

determining whether the medical sensor is within a predetermined distance of a charging device that is configured to provide power to the medical sensor if the medical sensor is operating in the wireless mode; and

providing a first indication to couple the medical sensor to the charging device in response to determining that the medical sensor is operating in the wireless mode and that the medical sensor is within the predetermine distance of the charging device.

9. The method of claim **8**, wherein providing the first indication comprises emitting light from at least one indicator light disposed on the medical sensor.

10. The method of claim **8**, wherein providing the first indication comprises providing an audible alarm from a speaker of the medical sensor or a speaker of the charging device.

11. The method of claim **8**, wherein providing the first indication comprises providing a visual indication on a display of a patient monitoring device operatively coupled to the medical sensor.

12. The method of claim **8**, comprising:

determining whether the medical sensor was coupled to the charging device within a predetermined period of time; and

providing a second indication to couple the medical sensor to the charging device in response to determining that the medical sensor was not coupled to the charging device within the predetermined period of time.

13. The method of claim **12**, wherein the second indication is provided by a pager in remote communication with the medical sensor or the charging device.

14. The method of claim **12**, wherein the first indication is provided as an audible tone with a first property and the second indication is provided as an audible tone with a second property.

15. The method of claim **12**, wherein the first indication is provided as an audible tone with a first volume and the second indication is provided as an audible tone with a second volume that is greater than the first volume.

16. A system, comprising:

a charging device; and

a sensor configured to measure a physiological signal of a patient, wherein the sensor is configured to operate in a wireless mode and a wired mode, and wherein the sensor comprises:

a power source configured to power the sensor when the sensor is operating in the wireless mode;

a proximity detector configured to generate one or more signals relating to a distance between the sensor and the charging device; and

a transceiver configured to wirelessly transmit the physiological signal or the one or more signals generated by the proximity detector at least when the sensor is operating in the wireless mode; and

wherein the charging device is configured to provide power to the sensor when the sensor is coupled to the charging device.

17. The system of claim **16**, comprising a monitor configured to receive the physiological signal from the sensor, wherein the monitor comprises a processor configured to calculate a physiological parameter of the patient based at least in part upon the signal, and wherein the monitor comprises the charging device.

18. The system of claim **17**, wherein the sensor comprises a pulse oximetry sensor, and wherein the physiological parameter comprises blood oxygen saturation.

19. The system of claim **17**, wherein the monitor comprises a transceiver configured to receive, from the transceiver of the sensor, the one or more signals generated by the proximity detector, and wherein the processor is configured to determine whether the sensor is located within a predetermined distance of the monitor based at least in part upon the one or more signals.

20. The system of claim **19**, wherein the monitor comprises a display, and wherein the processor is configured to cause the display to display an indication to couple the sensor to the monitor.

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专利名称(译)	用于对传感器进行消毒和充电的系统和方法		
公开(公告)号	US20140266695A1	公开(公告)日	2014-09-18
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[标]申请(专利权)人(译)	柯惠有限合伙公司		
申请(专利权)人(译)	COVIDIEN LP		
当前申请(专利权)人(译)	COVIDIEN LP		
[标]发明人	ADDISON PAUL S WATSON JAMES N DRIPPS JAMES H MANNING GEORGE K		
发明人	ADDISON, PAUL S. WATSON, JAMES N. DRIPPS, JAMES H. MANNING, GEORGE K.		
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摘要(译)

提供了用于对传感器进行消毒和再充电的方法和系统。传感器可以是无线传感器，或者传感器可以被配置为以无线模式和有线模式操作。该系统可以包括充电装置，该充电装置被配置为向传感器提供电力和/或为传感器的电源再充电。传感器可以包括接近检测器，其被配置为提供与传感器与充电装置的接近度有关的信息。另外，传感器可以包括另外的传感器，其配置成提供与用于消毒传感器的消毒过程有关的信息。