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(54) **METHOD AND APPARATUS FOR
DETECTING MISAPPLIED SENSORS**

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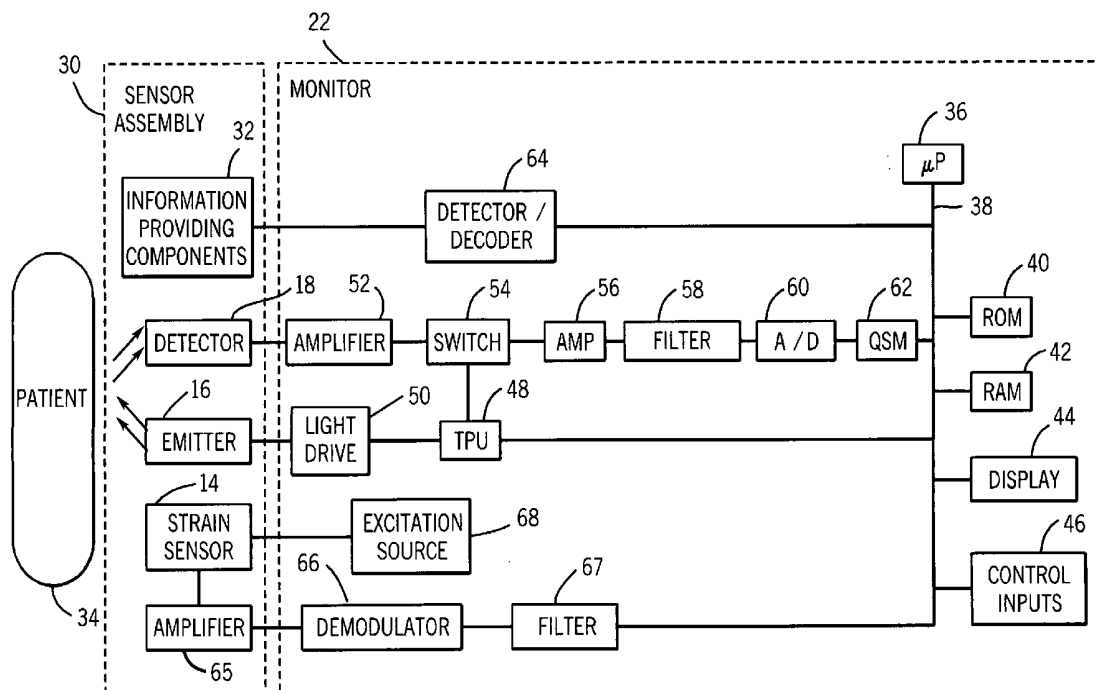
(57) **ABSTRACT**

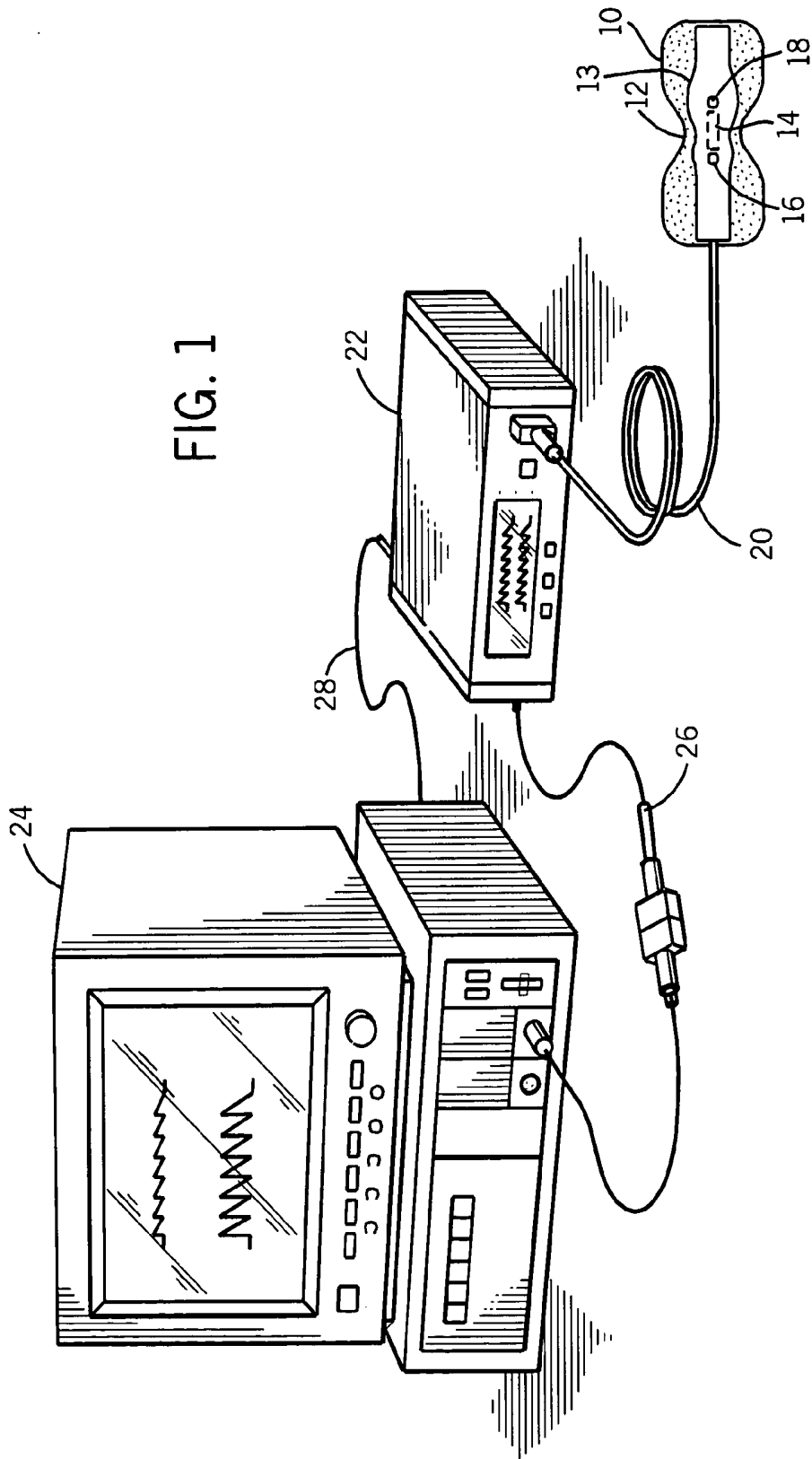
A method and system are provided for determining whether a spectrophotometric sensor is misapplied. In one embodiment, a spectrophotometric sensor is provided with a strain sensor configured to provide a signal related to the curvature of the spectrophotometric sensor. In such an embodiment, the signal may be compared, such as by an associated monitor, with an expected signal value. Based upon this comparison, a determination may be made whether or not the spectrophotometric sensor is misapplied.

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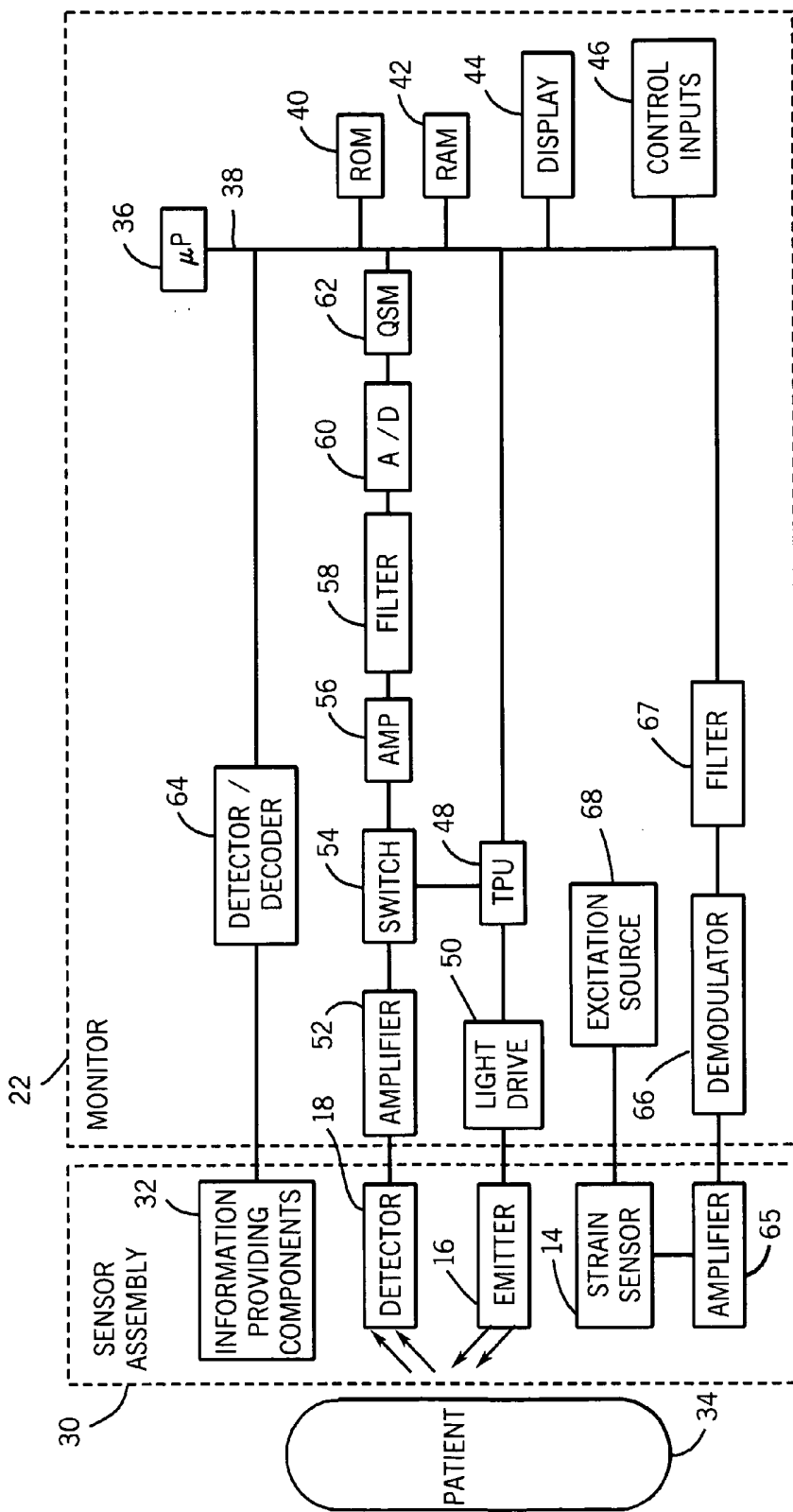


FIG. 2A

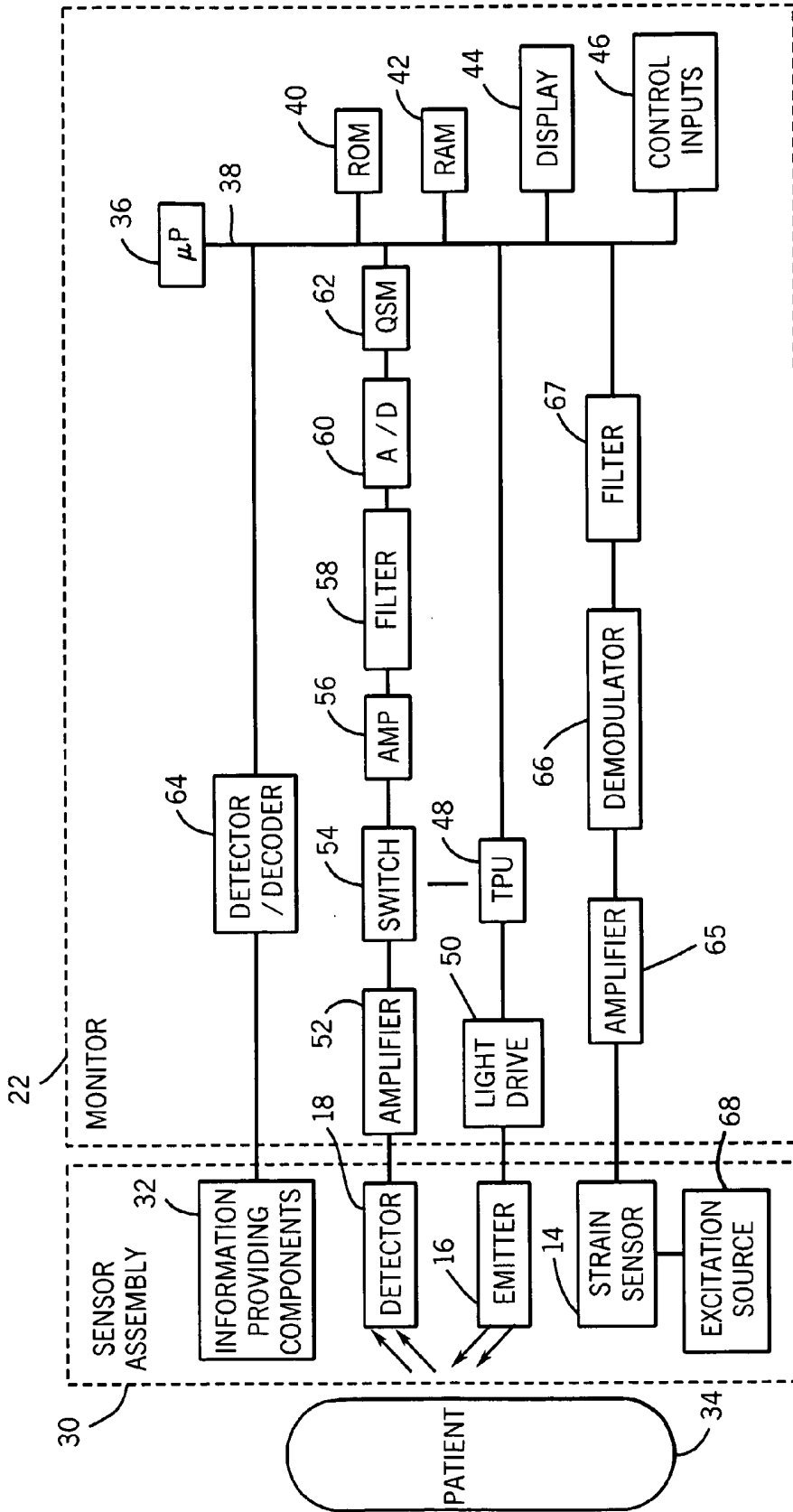


FIG. 2B

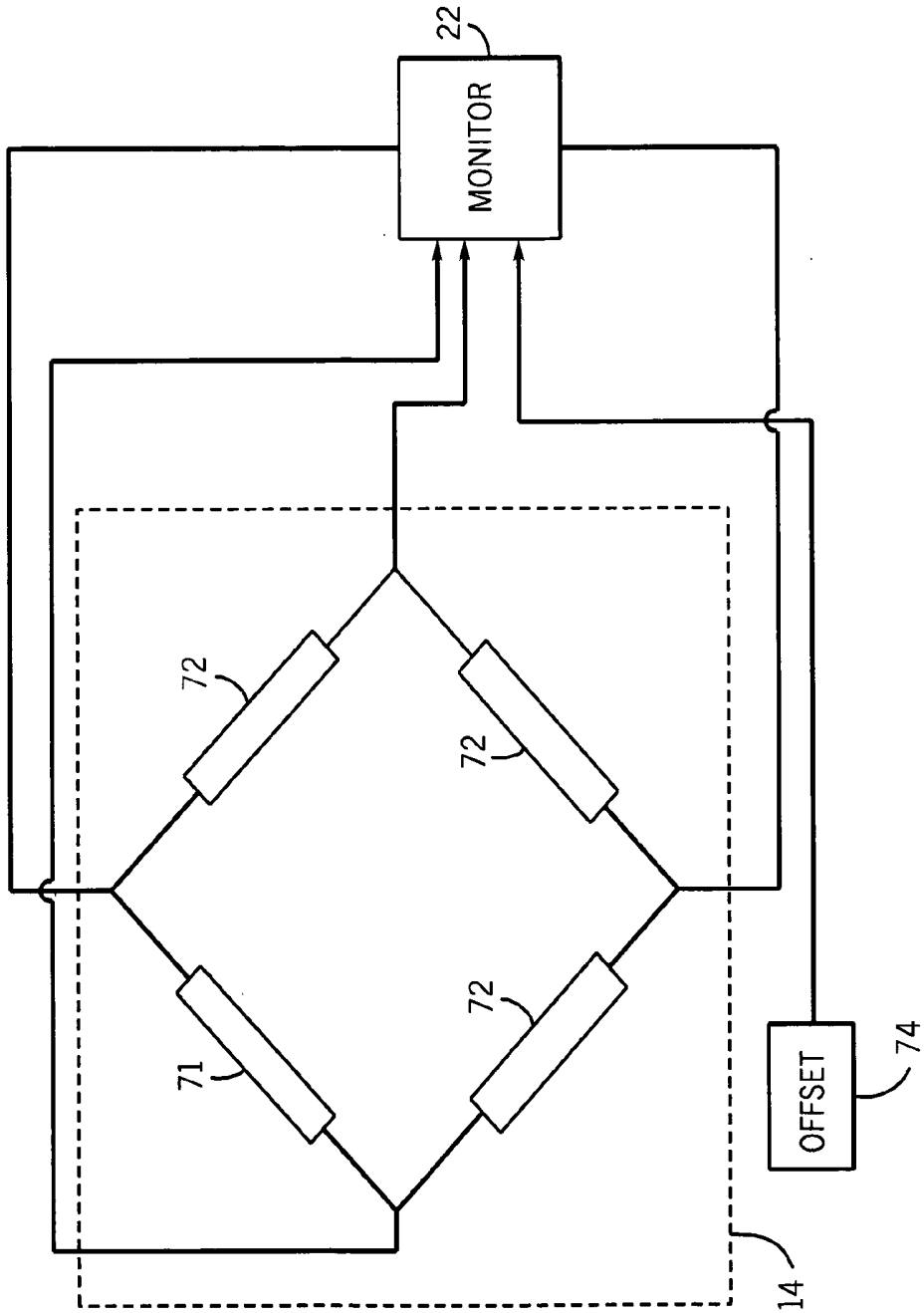


FIG. 3A

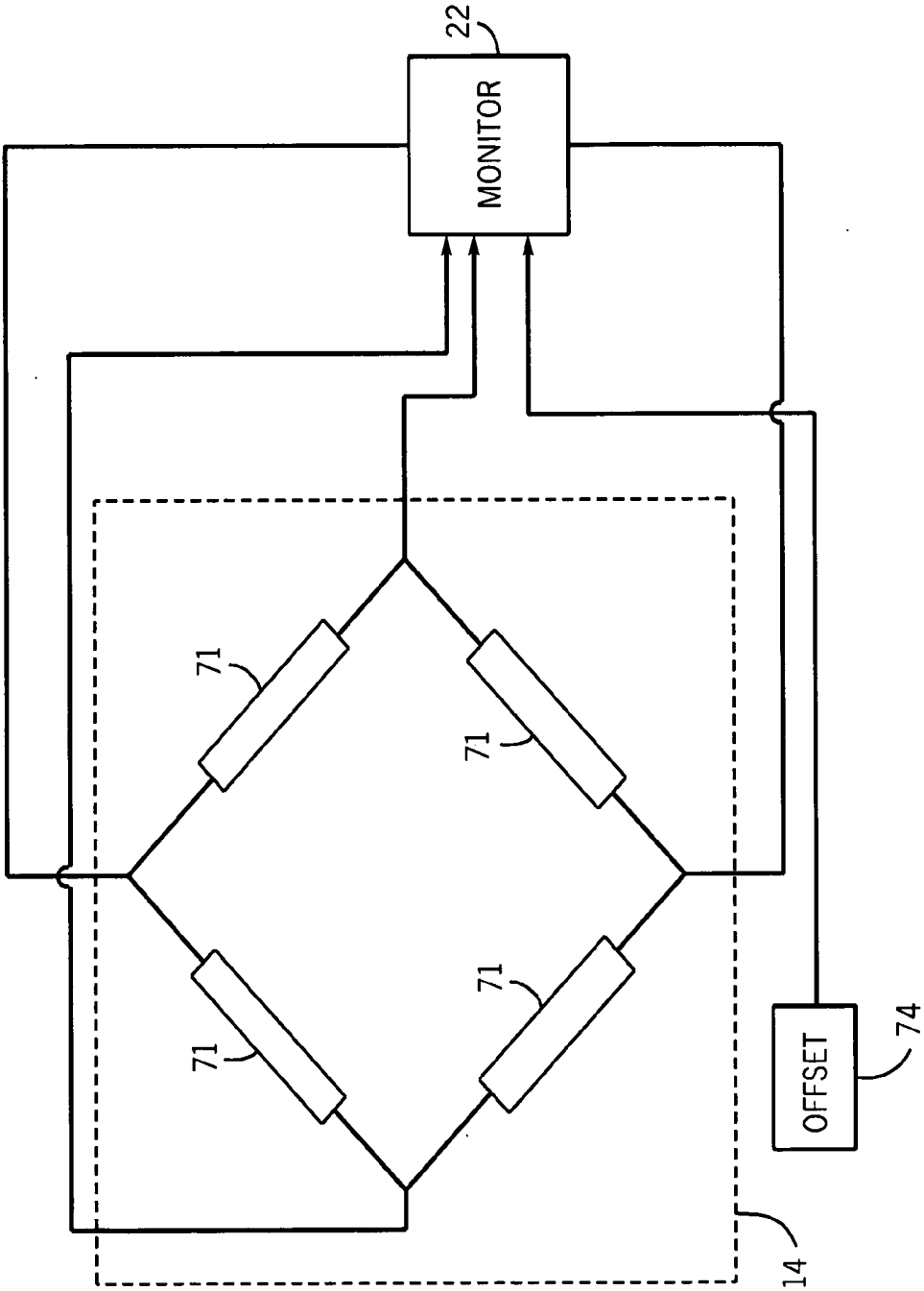


FIG. 3B

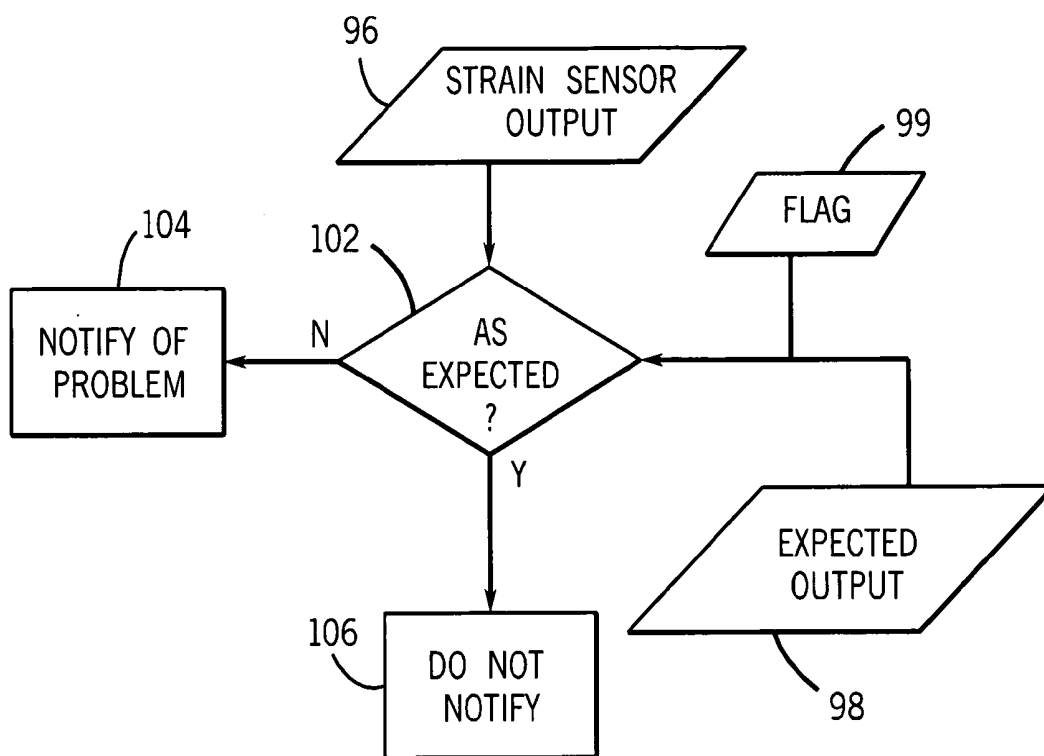


FIG. 4

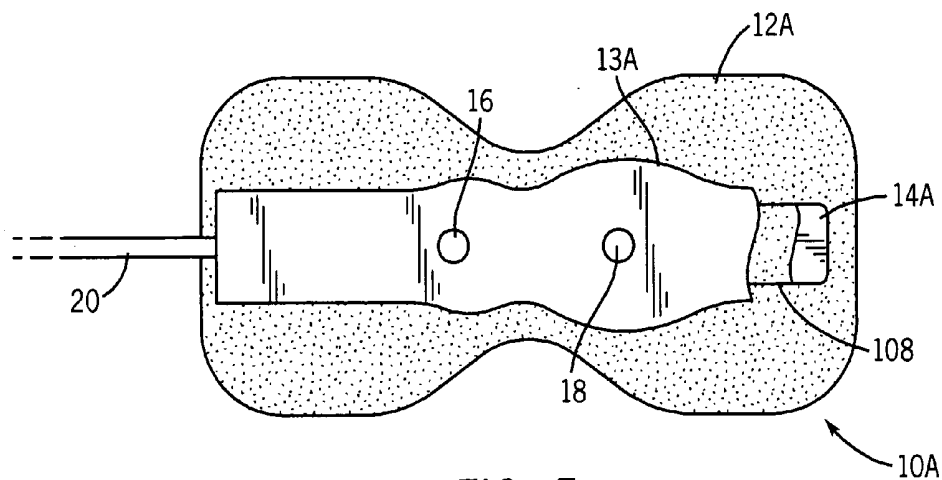


FIG. 5

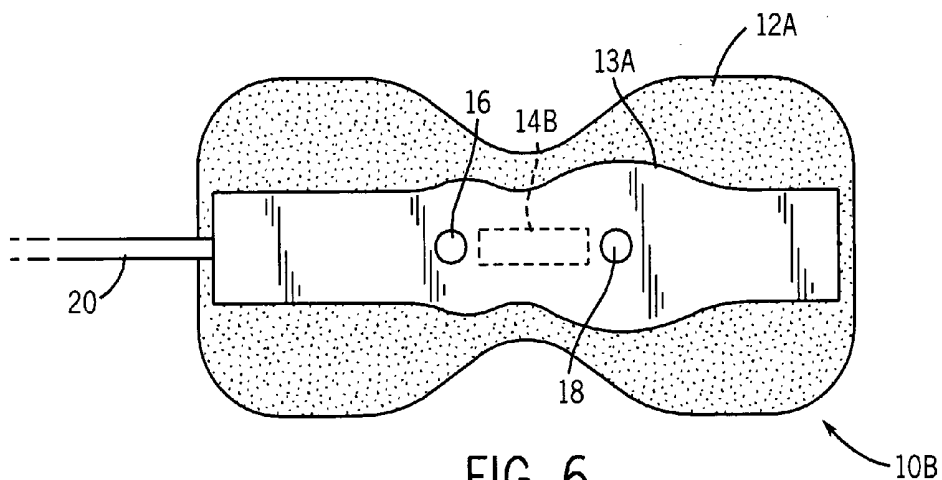


FIG. 6

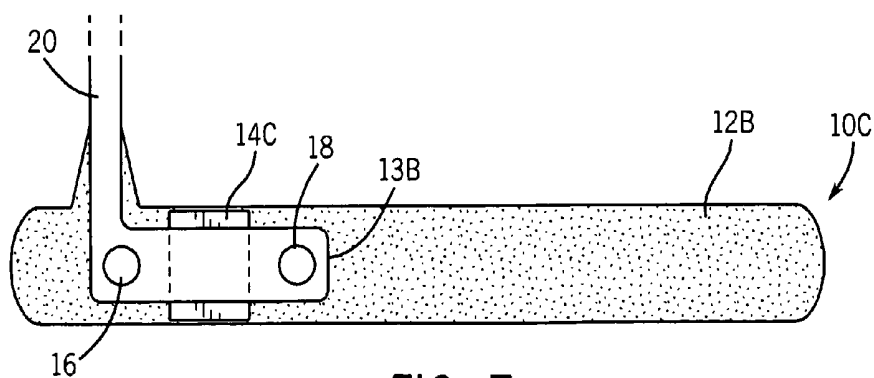


FIG. 7

METHOD AND APPARATUS FOR DETECTING MISAPPLIED SENSORS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to medical devices and, more particularly, to sensors used for sensing physiological parameters of a patient.

[0003] 2. Description of the Related Art

[0004] This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention, 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 invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

[0005] 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.

[0006] 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.

[0007] Pulse oximeters typically utilize a non-invasive sensor that transmits light through a patient's tissue and that photoelectrically detects the absorption and/or scattering of the transmitted light in such tissue. One or more of the above physiological characteristics may then be calculated based upon the amount of light absorbed or scattered. More specifically, the light passed through the tissue is typically selected to be of one or more wavelengths that may be absorbed or scattered by the blood in an amount correlative to the amount of the blood constituent present in the blood. The amount of light absorbed and/or scattered may then be used to estimate the amount of blood constituent in the tissue using various algorithms.

[0008] Sensors exist that are designed to be applied to different areas on a patient, such as the forehead, nose, or digits. To facilitate accurate and reliable measurements when monitoring physiological characteristics of a patient, a sensor should be properly applied to the area for which it was designed. That is, a digit sensor that is improperly

applied to a patient's forehead, as is often observed in a clinical setting, may produce inaccurate results due to its improper placement.

SUMMARY

[0009] Certain aspects commensurate in scope with the claimed invention are set forth below. It should be understood that these aspects are presented merely to provide the reader with a brief summary of certain forms that the invention might take and that these aspects are not intended to limit the scope of the invention. Indeed, the invention may encompass a variety of aspects that may not be set forth below.

[0010] There is provided a spectrophotometric sensor including: a sensor body; an emitter and a detector disposed on the sensor body; and a strain sensor disposed on the sensor body, wherein the strain sensor is configured to provide a signal related to a curvature of the spectrophotometric sensor.

[0011] There is also provided a system including: a monitor; and a spectrophotometric sensor adapted to be operatively coupled to the monitor, where the sensor includes: a sensor body; an emitter and a detector disposed on the sensor body; and a strain sensor disposed on the sensor body, wherein the strain sensor is configured to provide a signal related to a curvature of the spectrophotometric sensor.

[0012] There is also provided a method of manufacturing a sensor, including: providing an optical package in which an emitter and a detector are disposed; combining the optical package and a strain sensor such that a signal related to a curvature of the optical package can be measured; and disposing the strain sensor and the optical package on a sensor body.

[0013] There is also provided a method for detecting a misapplied sensor, including: receiving a signal related to a curvature of a spectrophotometric sensor at a monitor; comparing the signal with a threshold signal value; and providing a notification if the comparison indicates that the spectrophotometric sensor is misapplied.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Advantages of the invention may become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0015] FIG. 1 illustrates a pulse oximetry system coupled to a multi-parameter patient monitor and a sensor according to aspects of the present technique;

[0016] FIG. 2A is a block diagram of one embodiment of a system that may be configured to implement embodiments of the present technique;

[0017] FIG. 2B is a block diagram of an alternative embodiment of a system that may be configured to implement other embodiments of the present technique;

[0018] FIG. 3A is a block diagram of one embodiment of a strain sensor in accordance with aspects of the present technique;

[0019] FIG. 3B is a block diagram of an alternative embodiment of a strain sensor in accordance with aspects of the present technique;

[0020] FIG. 4 is a flow chart of exemplary actions associated with determining whether a sensor is applied to the area for which it was designed in accordance with aspects of the present technique;

[0021] FIG. 5 is a cutaway view of a sensor assembly according to one embodiment of the present technique;

[0022] FIG. 6 is a plan view of a sensor assembly according to another embodiment of the present technique; and

[0023] FIG. 7 is a plan view of a sensor assembly according to a further embodiment of the present technique.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

[0024] One or more specific embodiments of the present invention 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.

[0025] In accordance with the present technique, medical sensors for pulse oximetry or other applications utilizing spectrophotometry are provided that may provide a signal related to the misapplication of the sensor. As provided herein, the spectrophotometric sensors may include one or more strain sensors in accordance with embodiments of the present technique. Such strain sensors may relay a signal to a downstream medical device in order to convey an incorrect application of the spectrophotometric sensor to a healthcare practitioner, for example when a digit sensor is placed on a patient's forehead. By providing information related to the correct placement of a spectrophotometric sensor, strain sensors as provided herein may reduce measurement errors that may result from a spectrophotometric sensor being applied improperly.

[0026] FIG. 1 illustrates a spectrophotometric sensor 10 used in conjunction with a downstream medical device, which may include a pulse oximetry monitor 22. Spectrophotometric sensor 10 may include a sensor body 12, a flexible optical package 13 and a strain sensor 14. It should be appreciated that the optical package 13 may include an emitter 16 and a detector 18. In addition, as discussed below with reference to FIG. 6, the optical package may also include the strain sensor 14 in certain embodiments. Alternatively, the strain sensor 14 may be a separate component from the optical package 13 on the spectrophotometric sensor 10.

[0027] The optical package 13 may be disposed on a sensor body 12, which may be made of any suitable material, such as plastic, foam, woven material, or paper. In the depicted embodiments, the spectrophotometric sensor 10 is coupled to a cable 20 that is responsible for transmitting electrical and/or optical signals to and from the strain sensor 14, the emitter 16 and the detector 18. The cable 20 may be permanently coupled to the spectrophotometric sensor 10, or it may be removably coupled to the spectrophotometric sensor 10, the latter alternative being more useful and cost efficient in situations where the spectrophotometric sensor 10 is disposable. It should be appreciated that the cable 20 of the spectrophotometric sensor 10 may be coupled to the

monitor 22 or it may be coupled to a transmission device (not shown) to facilitate wireless transmission between the spectrophotometric sensor 10 and the monitor 22. In an exemplary embodiment, the monitor 22 may be any suitable pulse oximeter, such as those available from Nellcor Puritan Bennett Inc. Furthermore, to upgrade conventional pulse oximetry provided by the monitor 22 to provide additional functions, the monitor 22 may be coupled to a multi-parameter patient monitor 24 via a cable 26 connected to a sensor input port or via a cable 28 connected to a digital communication port.

[0028] The emitter 16 and the detector 18 may be of any suitable type. For example, the emitter 16 may be one or more light emitting diodes adapted to transmit one or more wavelengths of light, and the detector 18 may be one or more photodetectors selected to receive light in the range or ranges emitted from the emitter 16. Alternatively, the emitter 16 may also be a laser diode or a vertical cavity surface emitting laser (VCSEL). The emitter 16 and the detector 18 may also include optical fiber sensing elements. The emitter 16 may include a broadband or "white light" source, in which case the detector could include any of a variety of elements for selecting specific wavelengths, such as reflective or refractive elements or interferometers. These kinds of emitters and/or detectors would typically be coupled to the spectrophotometric sensor via fiber optics. Alternatively, a spectrophotometric sensor 10 may sense light detected from the tissue at a different wavelength from the light emitted into the tissue. Such sensors may be adapted to sense fluorescence, phosphorescence, Raman scattering, Rayleigh scattering and multi-photon events or photoacoustic effects. For pulse oximetry applications using either transmission or reflectance type spectrophotometric sensors the oxygen saturation of the patient's arterial blood may be determined using two or more wavelengths of light, most commonly red and near infrared wavelengths. Similarly, in other applications, a tissue water fraction (or other tissue constituent related metric) or a concentration of one or more biochemical components in an aqueous environment may be measured using two or more wavelengths of light. In certain embodiments, these wavelengths may be infrared wavelengths between about 1,000 nm and about 2,500 nm. 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, infrared, visible, ultraviolet, or X-ray spectra, and that any suitable wavelength of light may be appropriate for use with the present techniques.

[0029] The spectrophotometric sensor 10 may be either a transmission or reflectance type sensor. Transmission type spectrophotometric sensors include an emitter 16 and a detector 18 that are typically placed on opposing sides of the sensor site. If the sensor site is a fingertip, for example, the spectrophotometric sensor 10 is positioned over the patient's fingertip such that the emitter 16 and the detector 18 lie on either side of the patient's nail bed. In other words, the spectrophotometric sensor 10 is positioned so that the emitter 16 is located on the patient's fingernail and the detector 18 is located 180° opposite the emitter 16 on the patient's finger pad. During operation, the emitter 16 shines one or more wavelengths of light through the patient's fingertip and the light received by the detector 18 is processed to deter-

mine various physiological characteristics of the patient. In each of the embodiments discussed herein, it should be understood that the locations of the emitter 16 and the detector 18 may be exchanged. For example, the detector 18 may be located at the top of the finger and the emitter 16 may be located underneath the finger. In either arrangement, the spectrophotometric sensor 10 will perform in substantially the same manner.

[0030] Reflectance type spectrophotometric sensors also operate by emitting light into the tissue and detecting the light that is transmitted and scattered by the tissue. However, reflectance type sensors include an emitter 16 and a detector 18 that are typically placed on the same side of the sensor site. For example, a reflectance type sensor may be placed on a patient's forehead or foot such that the emitter 16 and detector 18 lie side-by-side. Reflectance type spectrophotometric sensors detect light photons that are scattered back to the detector 18. A spectrophotometric sensor 10 may also be a transreflectance sensor, such as a sensor that may subtend a portion of a baby's heel.

[0031] FIGS. 2A and 2B are block diagrams of possible embodiments of the present invention. For simplicity, like reference numerals have been used to designate those features previously described in regard to FIG. 1. Turning now to FIG. 2A, a sensor assembly 30 is shown which may contain the strain sensor 14, the emitter 16, the detector 18 and one or more information providing components 32. The sensor assembly 30 may include the spectrophotometric sensor 10 alone or the spectrophotometric sensor 10 and the cable 20 together.

[0032] In one embodiment of the present invention, the information providing components 32 may provide signals to enable the monitor 22 to look up information needed for calculations and comparisons (such as information stored in the monitor 22). Information used in calculations may include, for example, coefficients needed to calculate blood-oxygen saturation, which could be looked up based on the wavelength of light from emitter 16. In addition, information about the expected strain sensor output for a given sensor assembly 30 may be looked up based on the type of spectrophotometric sensor 10 used. In another embodiment, the information providing components 32 may provide the monitor 22 with the necessary information directly. For instance, the expected strain sensor output for sensor assembly 30 may be provided to the monitor 22 by the information providing components 32 rather than being looked up from a table. The information providing components 32 may include resistors, memory chips or other memory media.

[0033] In one embodiment of the present technique, light from emitter 16 passes into blood perfused tissue of a patient 34 where it is scattered then detected by detector 18. The sensor assembly 30 may be configured to transmit signals from the detector 18 to the monitor 22. The monitor 22 may include a microprocessor 36 connected to an internal bus 38. Also connected to the bus are a read-only memory (ROM) 40, a random access memory (RAM) 42, a display 44 and one or more control inputs 46. A time processing unit (TPU) 48 provides timing control signals to light drive circuitry 50 which controls when the emitter 16 is illuminated, and if multiple light sources are used, the multiplexed timing for the different light sources. TPU 48 also controls the gating-in of signals from detector 18 through an amplifier 52 and a switching circuit 54. These signals are sampled at the proper time, depending upon which of multiple light sources is

illuminated, if multiple light sources are used. Signals received from the detector 18 may be passed through an amplifier 56, a filter 58 and an analog-to-digital converter 60. The digital data is then stored in a queued serial module (QSM) 62, for later downloading to RAM 42 as QSM 62 fills up. In one embodiment, there may be multiple parallel paths of separate amplifier, filter and converter for multiple signals received.

[0034] Based on the value of the received signals corresponding to the light received by detector 18, microprocessor 36 may calculate the oxygen saturation using various algorithms. These algorithms require coefficients, which may be empirically determined corresponding to, for example, the wavelengths of light used. Information on the wavelengths used may be provided to the monitor 22 from the information providing components 32 or from separate information providing components from those shown. The signal from the information providing components 32 may pass to a detector/decoder 64, which may further process the signal, and/or may pass instructions to the microprocessor 36 to look up coefficient values. These values may be stored in a look up table in the ROM 40. In a two-wavelength system, the particular set of coefficients chosen for any pair of wavelength spectra is determined by the value indicated by the information providing components 32 corresponding to a particular light source in a particular sensor assembly 30. In one embodiment, multiple resistor values may be assigned to select different sets of coefficients. In another embodiment, the same resistors are used to select from among the coefficients appropriate for an infrared source paired with either a near red source or far red source. The selection between whether the near red or far red set will be chosen can be selected with a control input from control inputs 46. Control inputs 46 may be, for instance, a switch on the pulse oximeter, a keyboard, or a port providing instructions from a remote host computer. Furthermore, any number of methods or algorithms may be used to determine a patient's pulse rate, oxygen saturation or any other desired physiological parameter.

[0035] The monitor 22 may also be configured to receive signals from the sensor assembly 30 related to the strain sensor 14 that may be processed by the monitor 22 to determine when the spectrophotometric sensor 10 is misapplied. The strain sensor 14 may be made of any suitable material capable of providing an output indicative of the degree to which spectrophotometric sensor 10 is being bent. For example, strain sensor 14 may include a piezoresistive material, a piezoelectric material, a bonded metallic material or any other strain-sensitive material such that the resistance of the material changes based on the strain on the material. In the depicted exemplary embodiment, signals received from the strain sensor 14 are passed through an amplifier 65, a demodulator 66 and a low-pass filter 67. It should be appreciated by one skilled in the art that the amplifier 65 could be located in the sensor assembly 30 or in the monitor 22. For example, the amplifier 65 may be included in the sensor assembly 30 (e.g., integrated into the spectrophotometric sensor 10 or incorporated into the cable 20) as illustrated in FIG. 2A. Alternatively, the amplifier 65 may be located before the demodulator 66 in the monitor 22, as illustrated in FIG. 2B.

[0036] In an exemplary embodiment, the output waveform of excitation source 68 may be selected to reduce the noise in the output of amplifier 65 by minimizing the effects of

thermoelectric potentials and of the 1/f noise and other noise characteristics of the amplifier 65. The excitation source 68 may be powered from any suitable source, such as a battery or wall outlet. To minimize coupling between the strain sensor 14 input and output and to minimize spurious radiation from the conductors carrying the excitation signal, a low-bandwidth excitation waveform may be used. Once again, it should be appreciated by one skilled in the art that this excitation source 68 could be located in the sensor assembly 30, as illustrated in FIG. 2A, or in the monitor 22, as illustrated in FIG. 2B. The combinations of amplifier 65 and excitation source 68 locations depicted are not the only possible combinations envisioned, but rather any combination may be possible. A demodulator 66 may convert the output signal from strain sensor 14 to a baseband signal. The demodulator 66 may be followed by a low-pass filter 67 to remove noise due to power-line frequency pickup, the amplifier, the operation of other apparatus applied to or in the vicinity of the patient, and all other sources of interfering signals. Bandpass filtering may also be employed in the amplifier 65 for the same purpose.

[0037] Further, the monitor 22 may be configured to receive information about the strain sensor 14 from a memory chip or other device, such as the information providing components 32. Such a device may include a code or other identification parameter that may allow the monitor 22 to select an appropriate software or hardware instruction for processing the signal. For example, the information providing components 32 may provide information regarding the strain sensor 14 and the spectrophotometric sensor 10 to the monitor 22 to allow the monitor 22 to determine if the observed strain sensor output is consistent with the proper usage of spectrophotometric sensor 10. In one embodiment, these information providing components 32 may be configured to notify the monitor 22 of the type of spectrophotometric sensor 10 being used (e.g., forehead or digit) so that an expected strain sensor output may be looked up from a table on the monitor. In another embodiment, the information providing components 32 may supply the expected strain sensor output to the monitor 22.

[0038] The signal from the information providing components 32 may pass to a detector/decoder 64, which may further process the signal, and/or may pass instructions to a microprocessor 36. Further, a monitor 22 may run an algorithm or code for processing the signal provided by the strain sensor 14. For example, in certain embodiments, the processing algorithm may receive information that compares the strain sensor output to that expected of a certain type of sensor, providing for a determination of misapplication of spectrophotometric sensor 10 depending on the parameters of the particular strain sensor 14. The monitor 22 may also be configured to provide an indication about the sensor condition, such as an audio alarm, visual alarm or a display message, such as "CHECK SENSOR." One embodiment of this process is described below, in reference to FIG. 4.

[0039] FIGS. 3A and 3B are block diagrams of possible embodiments of the strain sensor 14 that may be configured to implement the present technique. The strain sensor 14 may consist of a bridge including one or more strain sensing elements 71 with impedance that varies as a function of the mechanical strain in the element. Any or all of the strain sensing elements 71 may incorporate components that reduce the output in the zero-strain condition to an acceptable level. The strain sensor 14 may also include one or more

resistors 72 to complete the bridge, depending on the number of strain sensing elements 71 used. FIG. 3A illustrates a strain sensor 14 in which only one strain sensing element 71 is used, while FIG. 3B illustrates a strain sensor 14 in which four strain sensing element 71 are used. As one skilled in the art will appreciate, the possible combinations of strain sensing elements 71 and resistors 72 are not limited to those shown but could be any combination in which at least one strain sensing element 71 is included in the bridge.

[0040] An offset element 74 (one possible information providing component 32) may be included in the sensor assembly 30 to provide information about the zero-strain offset output to the monitor 22, which may use this information to null out or otherwise account for the offset. As will be appreciated by those of ordinary skill in the art, the offset element 74 may also be provided in the monitor 22, though, for simplicity, it is depicted in FIGS. 3A and 3B as being a separate component. The interconnect assembly or assemblies may be constructed to minimize the pickup of all signals not due to the strain-induced output of the strain sensor 14, including cross-coupling between the bridge excitation and output signals.

[0041] FIG. 4 is a flow chart of exemplary actions associated with determining whether the spectrophotometric sensor 10 is applied to the area for which it was designed. This determination may be made by comparing the strain sensor output 96 to an output threshold 98 for a spectrophotometric sensor of the type being used. A flag 99 indicates whether the output threshold 98 is a high or low threshold. The flag 99 indicates whether the strain sensor output 96 is expected to be above or below the threshold output 98 when the spectrophotometric sensor 10 is applied correctly. In one embodiment of the present invention, the output threshold 98 and flag 99 may be stored in the information providing components 32. In another embodiment of the present invention, information about the type of spectrophotometric sensor 10 and strain sensor 14 being used is provided by the information providing components 32 and the output threshold 98 and flag 99 are looked up from a table stored in the ROM 40.

[0042] The strain sensor output 96 and the output threshold 98 may then be compared (Block 102). For example, in one embodiment of the present technique the output threshold 98 may be determined by measuring the expected strain sensor output when a digit sensor is applied to a digit with the largest radius of curvature expected, and the flag 99 may be set to indicate that a strain sensor output 96 greater than the output threshold 98 is unacceptable. For example, in one implementation, the output threshold 98 may be set to 0.7 volts and the flag 99 may indicate that this is a high threshold. Therefore, if the strain sensor output 96 were 0.9 volts the threshold would be exceeded, and if the strain sensor output 96 were 0.6 volts the threshold would not be exceeded. As one skilled in the art will appreciate, the output threshold 98 and flag 99 may vary depending on the type of material used in the strain sensor 14. The threshold may be chosen to provide the desired degrees of correct identification of a misapplied sensor and incorrect identification of a properly applied sensor. If the strain sensor output 96 is not as expected, the monitor 22 may provide an indication (Block 104) about the sensor condition, such as an audible alarm, visual alarm or a display message, such as "CHECK SENSOR." Alternatively, the monitor 22 may cease display of the patient's physiological characteristics as an indication

of incorrect spectrophotometric sensor placement. If the strain sensor output 96 is as expected, the monitor 22 may not indicate a sensor problem (Block 106).

[0043] FIGS. 5-7 illustrate spectrophotometric sensors 10 with various combinations of embodiments of sensor body 12, optical package 13 and strain sensor 14. The present technique is not intended to be limited to the combinations illustrated, but rather may include any combination of these embodiments or any other modifications, equivalents, and alternatives falling within the spirit and scope of the invention. Turning now to FIG. 5, a cutaway view of a spectrophotometric sensor 10A is shown according to one embodiment of the present technique. As described above in reference to FIG. 1, an optical package 13A may include the emitter 16 and the detector 18, and may be coupled to the cable 20. The optical package 13A may be attached to the strain sensor 14A via an adhesive layer 108 such that any bending of the optical package 13A results in a corresponding bend in a strain sensor 14A. The strain sensor 14A may run substantially the length of the optical package 13A or less and may also be coupled to the cable 20. The optical package 13A and strain sensor 14A may be disposed on a sensor body 12A, which may be configured for application to a particular area of the body, such as the forehead or digit.

[0044] FIG. 6 is a plan view of a spectrophotometric sensor 10B according to another embodiment of the present technique. The strain sensor 14B may be incorporated into the optical package 13A rather than being adhered to the exterior, as denoted by the dashed line. It should be appreciated that the strain sensor 14B may be located anywhere within the optical package 13A that would be expected to bend upon proper application of the spectrophotometric sensor 10B to the body area for which the spectrophotometric sensor 10B was designed. The strain sensor 14B may be configured such that it is as small as possible but still able to accurately provide a measurement related to the curvature of the optical package 13A.

[0045] FIG. 7 is a plan view of a spectrophotometric sensor 10C according to another embodiment of the present technique. The strain sensor 14C may be configured such that it is substantially perpendicular to an optical package 13B. It should be appreciated by one skilled in the art that the strain sensor 14C may be disposed at any angle relative to the optical package 13B as long as the strain sensor 14C generates a signal representative of the extent to which the spectrophotometric sensor 10 is bent or curved. The strain sensor 14C may be positioned completely under the optical package 13B or it may protrude from beneath the optical package 13B. In addition, the strain sensor 14C may be placed anywhere on the sensor body 12B that is expected to bend upon application of the spectrophotometric sensor 10C to the area of the body for which it was designed.

[0046] While the invention 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 invention is not intended to be limited to the particular forms disclosed. Indeed, the present techniques may not only be applied to measurements of blood oxygen saturation, but these techniques may also be utilized for the measurement and/or analysis of other blood constituents. For example, using the same, different, or additional wavelengths, the present techniques may be utilized for the measurement and/or analysis of carboxyhemoglobin, met-

hemoglobin, total hemoglobin, intravascular dyes, and/or water content. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

What is claimed is:

1. A spectrophotometric sensor comprising:
 - a sensor body;
 - an emitter and a detector disposed on the sensor body; and
 - a strain sensor disposed on the sensor body, wherein the strain sensor is configured to provide a signal related to a curvature of the spectrophotometric sensor.
2. The spectrophotometric sensor of claim 1, wherein the spectrophotometric sensor comprises at least one of a pulse oximetry sensor or a tissue water sensor configured to measure a water fraction.
3. The spectrophotometric sensor of claim 1, wherein the signal comprises a measure of one of a voltage or a resistance.
4. The spectrophotometric sensor of claim 1, wherein the signal comprises a measure of an electrical property of the strain sensor.
5. The spectrophotometric sensor of claim 1, wherein the strain sensor comprises at least one of a piezoresistive material, a piezoelectric material or a bonded metallic material.
6. The spectrophotometric sensor of claim 1, wherein the strain sensor is adhered to an optical package containing the emitter and the detector.
7. The spectrophotometric sensor of claim 1, wherein the strain sensor is disposed within an optical package containing the emitter and the detector.
8. The spectrophotometric sensor of claim 1, comprising an information providing component comprising at least a threshold signal value for the strain sensor.
9. The spectrophotometric sensor of claim 1, comprising an information providing component comprising at least identification information that may be utilized by a monitor to determine at least a threshold signal value for the strain sensor.
10. A system comprising:
 - a monitor; and
 - a spectrophotometric sensor adapted to be operatively coupled to the monitor, the spectrophotometric sensor comprising:
 - a sensor body;
 - an emitter and a detector disposed on the sensor body; and
 - a strain sensor disposed on the sensor body, wherein the strain sensor is configured to provide a signal related to a curvature of the spectrophotometric sensor.
11. The system of claim 10, wherein the monitor comprises a pulse oximetry monitor.
12. The system of claim 10, wherein the monitor is configured to compare the signal with a threshold signal value.
13. The system of claim 12, wherein the monitor is configured to determine whether the threshold signal value is a high threshold or a low threshold based on a signal flag.
14. The system of claim 12, wherein the monitor is configured to provide a notification when the comparison of the signal with the threshold signal value indicates that the spectrophotometric sensor is misapplied.

15. The system of claim **10**, wherein the monitor is configured to look up a threshold signal value based on information received from an information providing component of the spectrophotometric sensor.

16. The system of claim **10**, wherein the monitor is configured to receive a threshold signal value from an information providing component of the spectrophotometric sensor.

17. A method of manufacturing a sensor, comprising:
providing an optical package in which an emitter and a detector are disposed;
combining the optical package and a strain sensor such that a signal related to a curvature of the optical package can be measured; and
disposing the strain sensor and the optical package on a sensor body.

18. The method of claim **17**, wherein combining the strain sensor and the optical package comprises adhering the strain sensor to the optical package.

19. The method of claim **17**, wherein combining the strain sensor and the optical package comprises integrating the strain sensor into the optical package.

20. The method of claim **17**, wherein the strain sensor comprises at least one of a piezoresistive material, a piezoelectric material or a bonded metallic material.

21. A method for detecting a misapplied sensor, comprising:

receiving a signal related to a curvature of a spectrophotometric sensor at a monitor;

comparing the signal with a threshold signal value; and
providing a notification if the comparison indicates that the spectrophotometric sensor is misapplied

22. The method of claim **21**, wherein the threshold signal value depends on the body area to which the spectrophotometric sensor is configured to be applied.

23. The method of claim **21**, wherein providing a notification comprises at least one of sounding an audible alarm, displaying a message, or ceasing display of one or more physiological characteristics measured by the spectrophotometric sensor.

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专利名称(译)	用于检测误应用的传感器的方法和设备		
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摘要(译)

提供了一种用于确定分光光度传感器是否被误用的方法和系统。在一个实施例中，分光光度传感器设置有应变传感器，其配置为提供与分光光度传感器的曲率相关的信号。在这样的实施例中，可以例如通过相关联的监视器将信号与预期信号值进行比较。基于该比较，可以确定分光光度传感器是否被误用。

