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(54) **MULTI-LAYER ALARMING**

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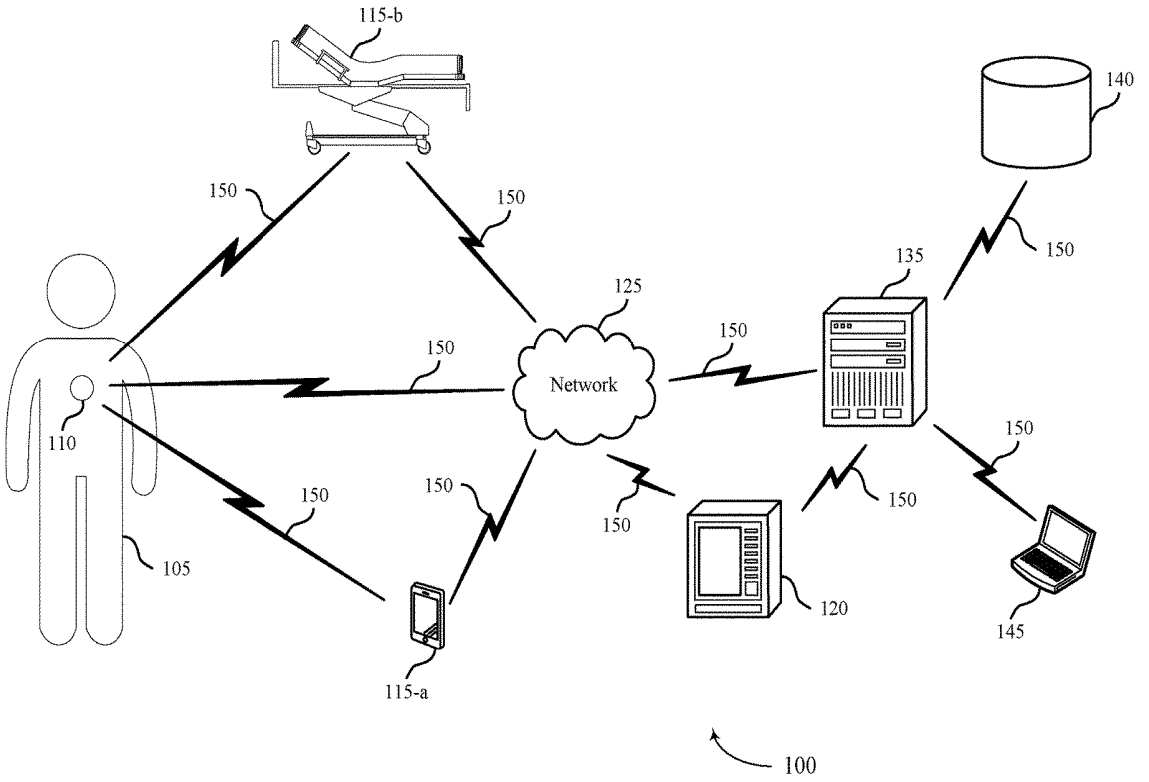
(57) **ABSTRACT**

Methods, systems, and devices for wireless patient monitoring are described. The methods, systems, and devices, provide a multi-layer alarm having multiple layers that indicate information associated with a patient being monitored by medical devices. The multi-layer alarm may be encoded with at least two layers of information, one layer indicating information related to severity of a measured parameter of the patient, and a second layer indicating other information related to the patient. The multi-layer alarm may be audibly transmitted allowing a clinician to be alerted of relevant information relating to the patient being monitored.



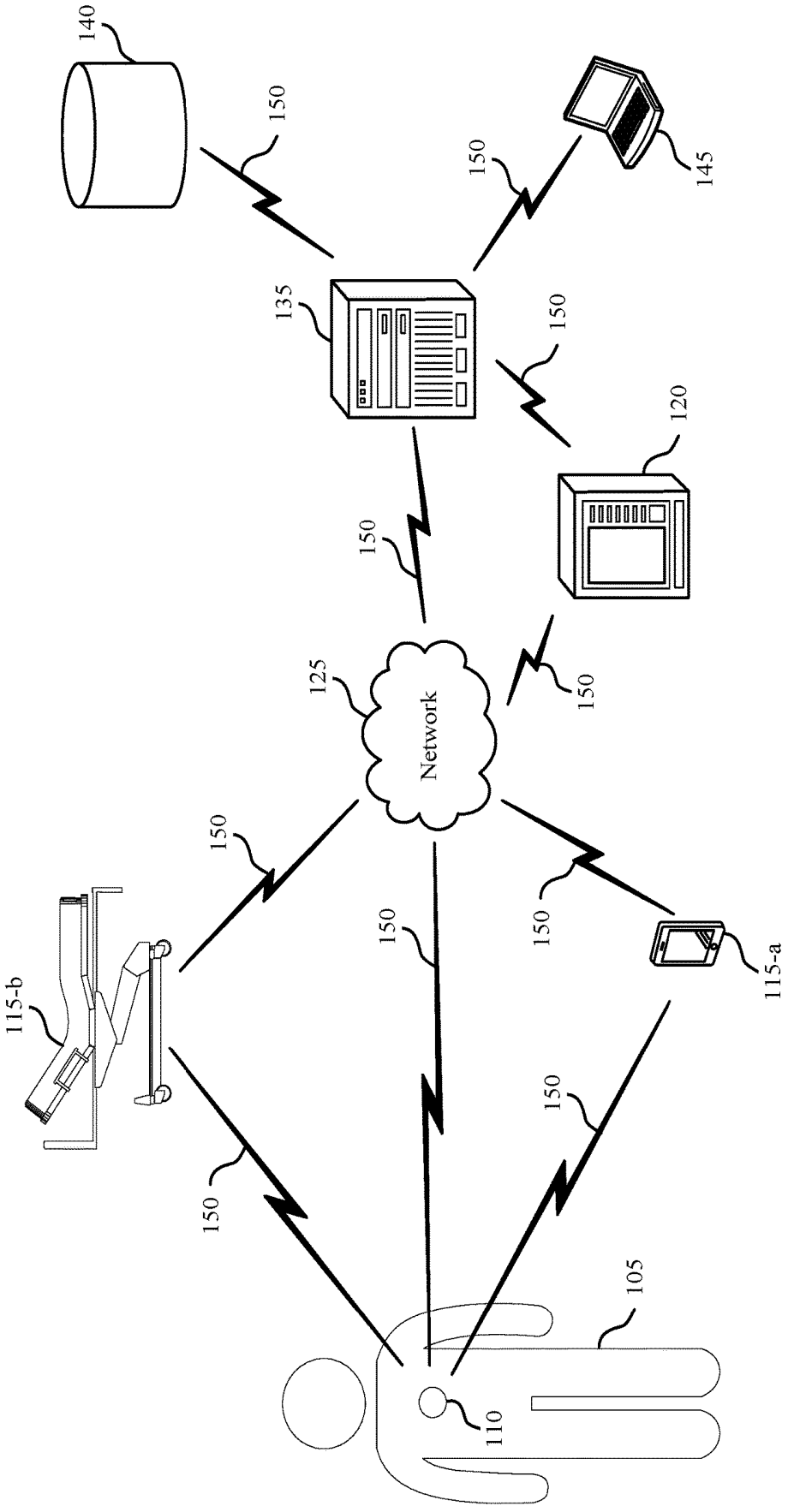

140
150
145
150
135
150
120
150
100
125
Network
150
150
150
115-a
115-b
150
150
105
110

FIG. 1

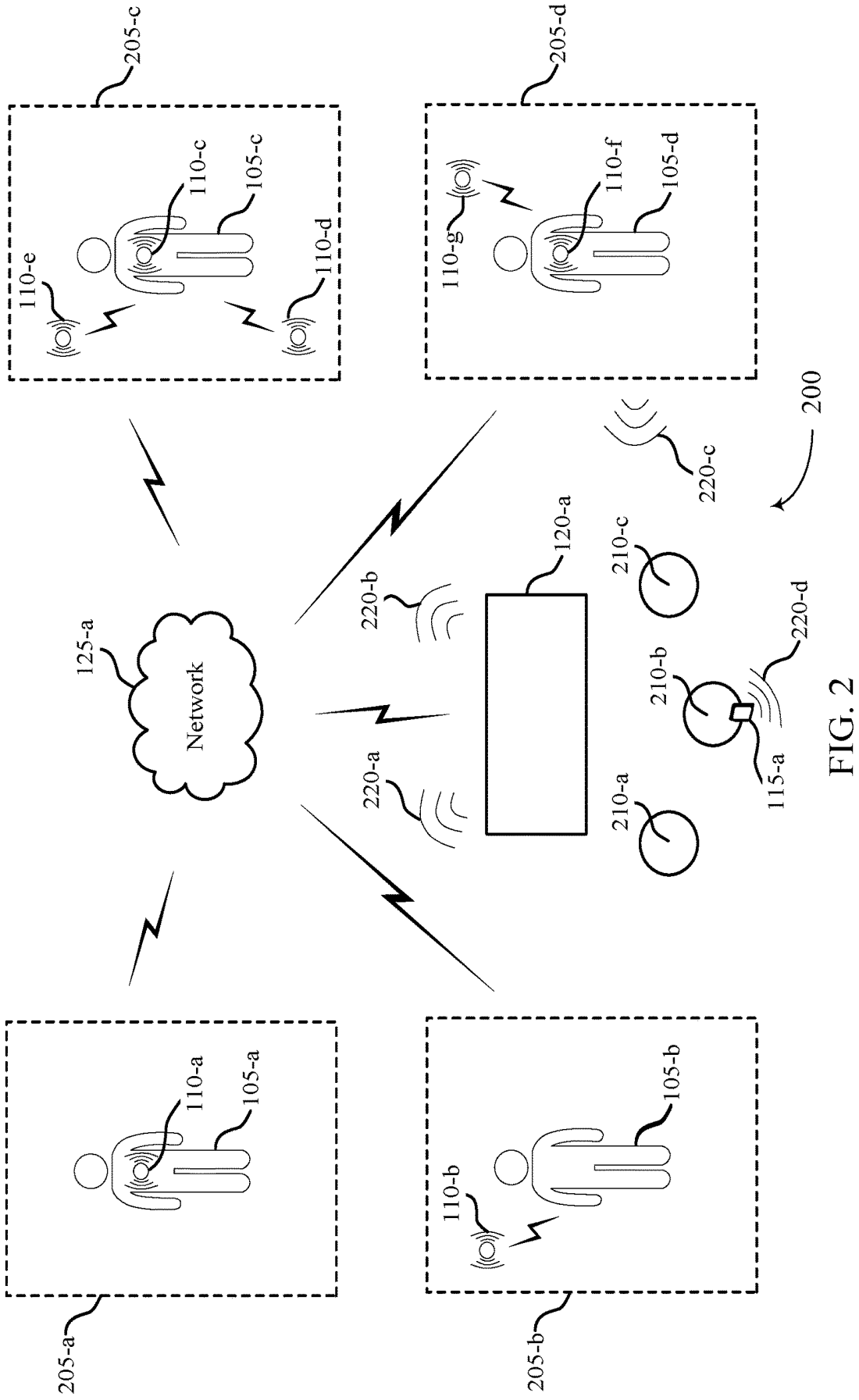

205-c
110-e
110-c
105-c
110-d
205-d
110-g
110-f
105-d
200
220-c
125-a
Network
220-b
120-a
210-c
220-d
210-b
220-a
210-a
115-a
205-a
110-a
105-a
205-b
110-b
105-b

FIG. 2

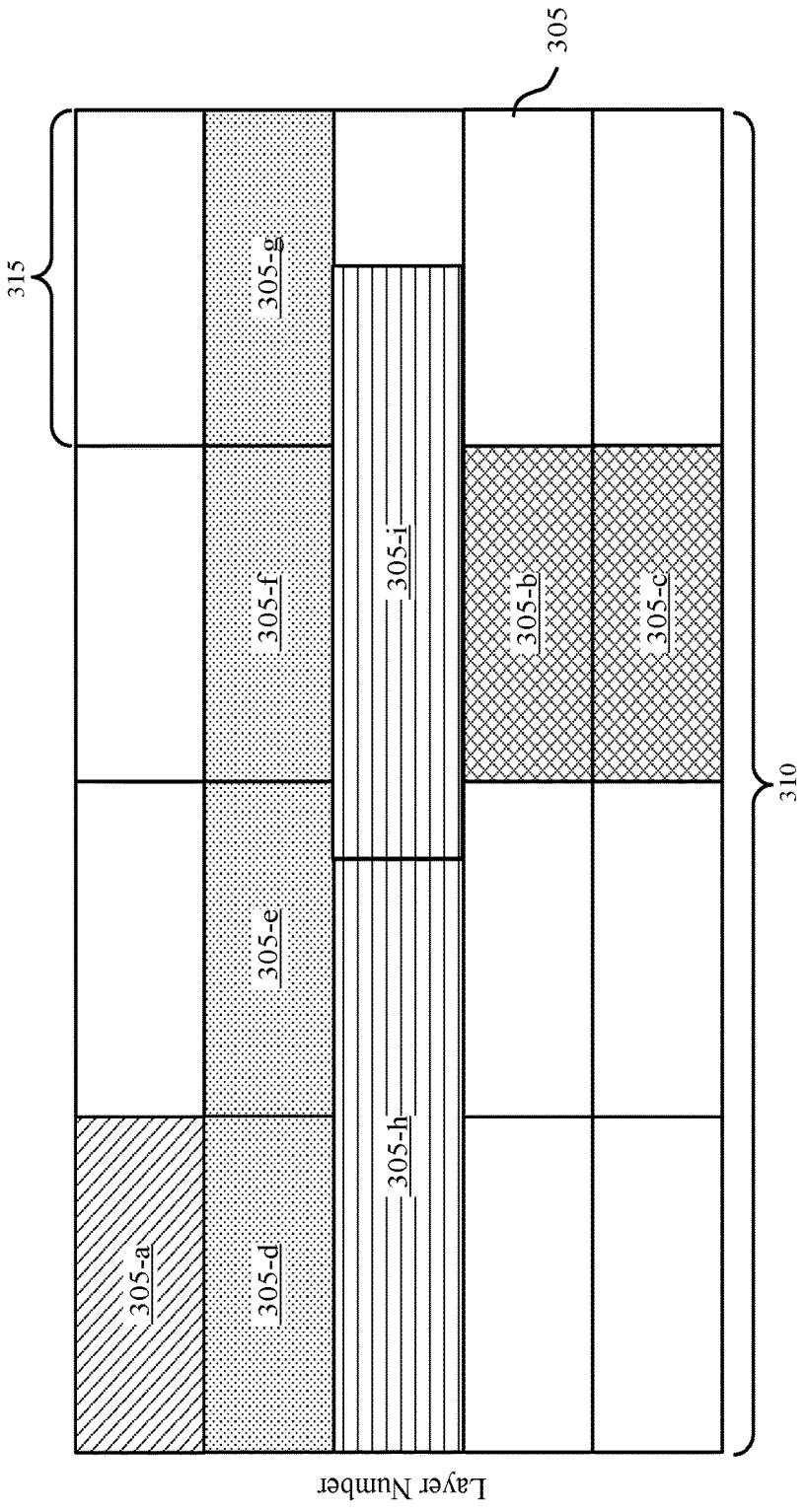

305
315
305-g
305-f
305-i
305-b
305-c
305-e
305-h
305-a
305-d
310
Layer Number
300

FIG. 3

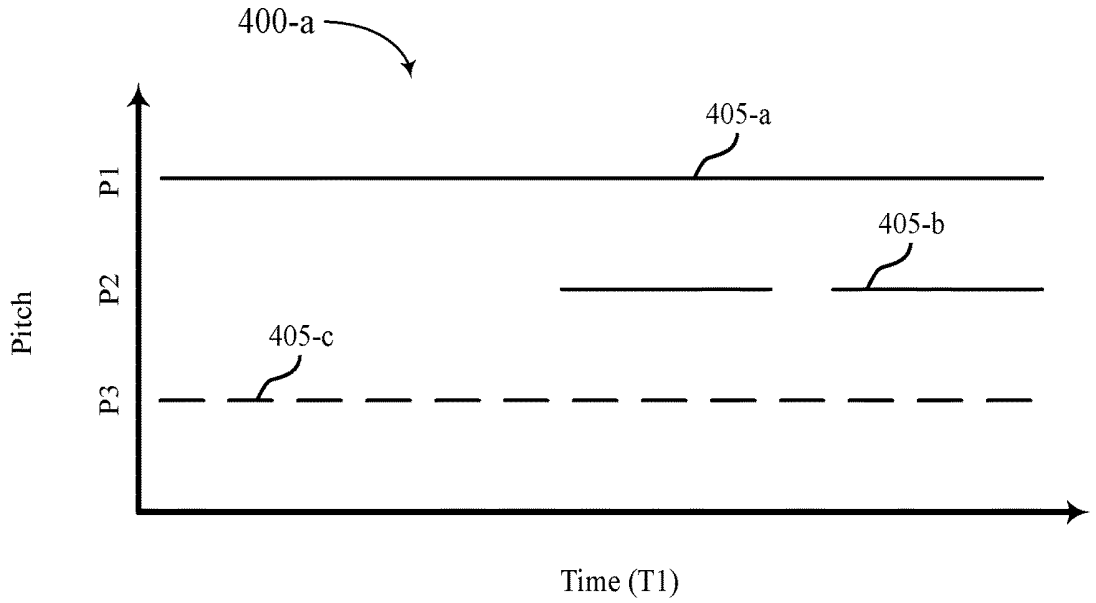

400-a
405-a
405-b
405-c
P1
P2
P3
Pitch
Time (T1)

FIG. 4A

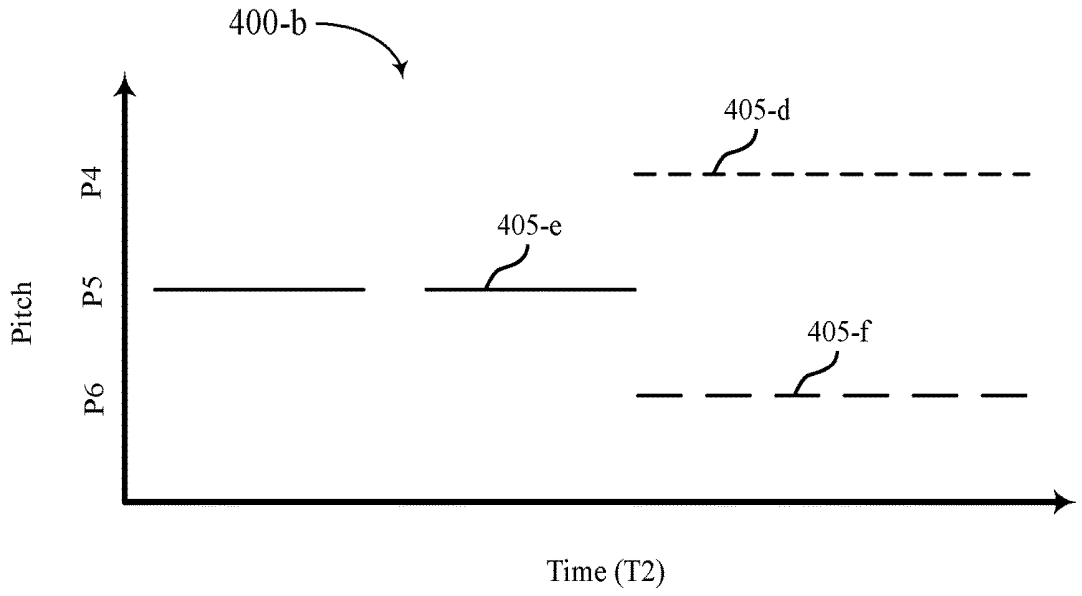

400-b
405-d
405-e
405-f
P4
P5
P6
Pitch
Time (T2)

FIG. 4B

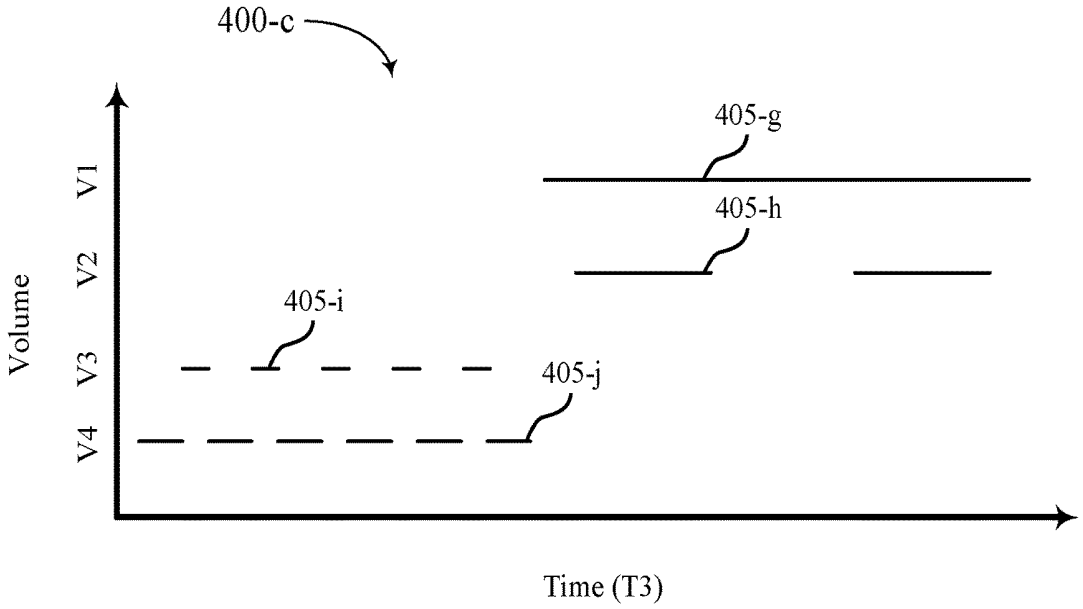

400-c
405-g
405-h
405-i
405-j
V1
V2
V3
V4
Volume
Time (T3)

FIG. 4C

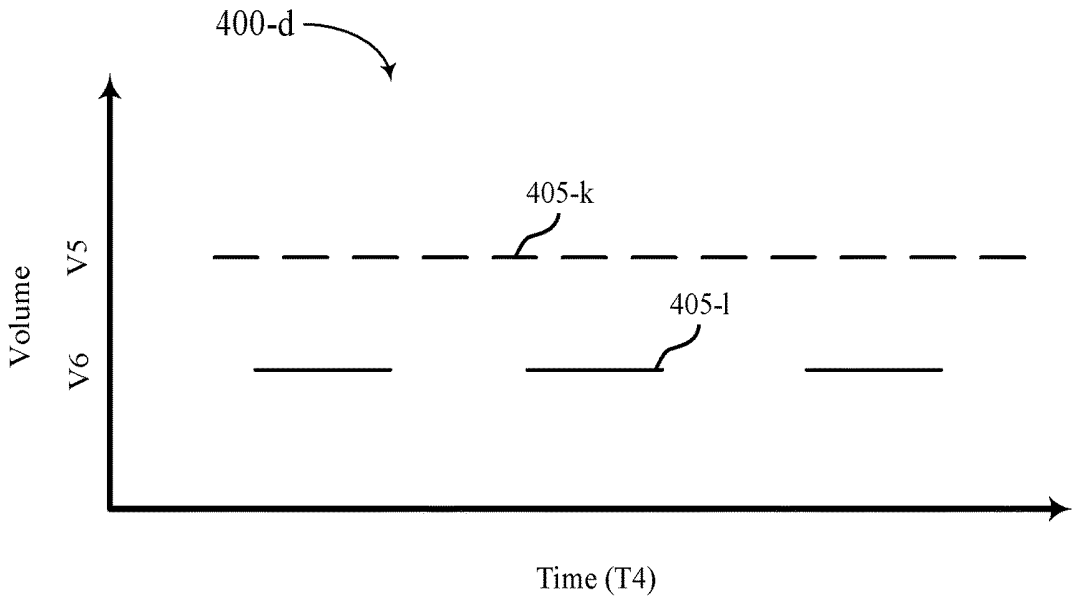

400-d
405-k
405-l
V5
V6
Volume
Time (T4)

FIG. 4D

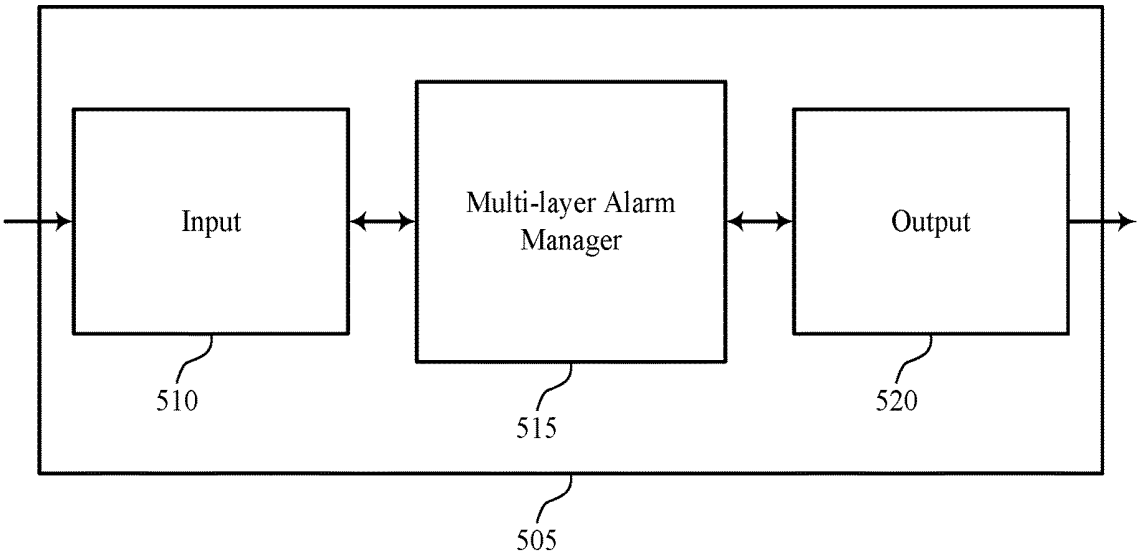


FIG. 5

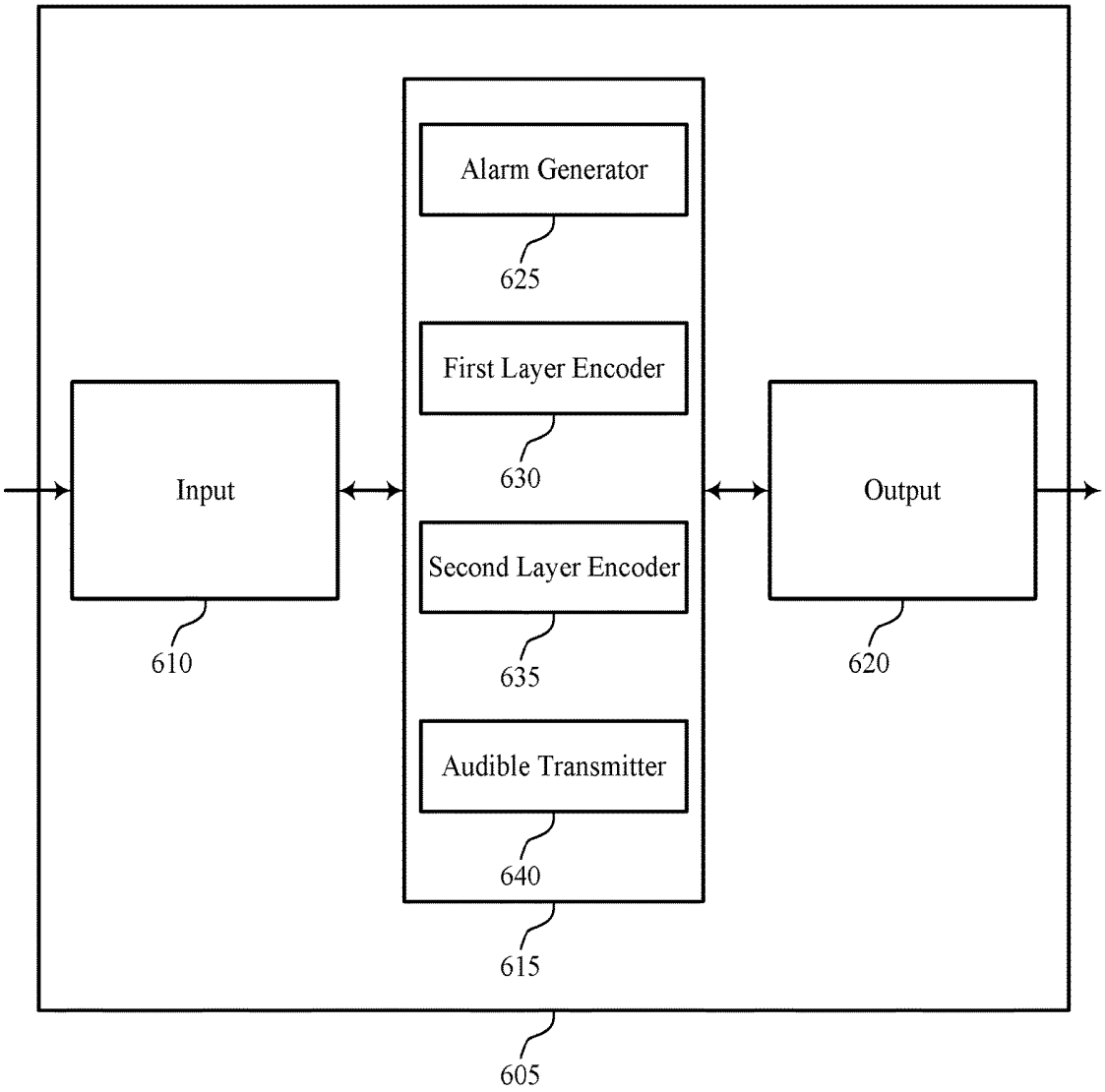

Alarm Generator
625
First Layer Encoder
630
Second Layer Encoder
635
Audible Transmitter
640
615
Input
610
Output
620
605
600

FIG. 6

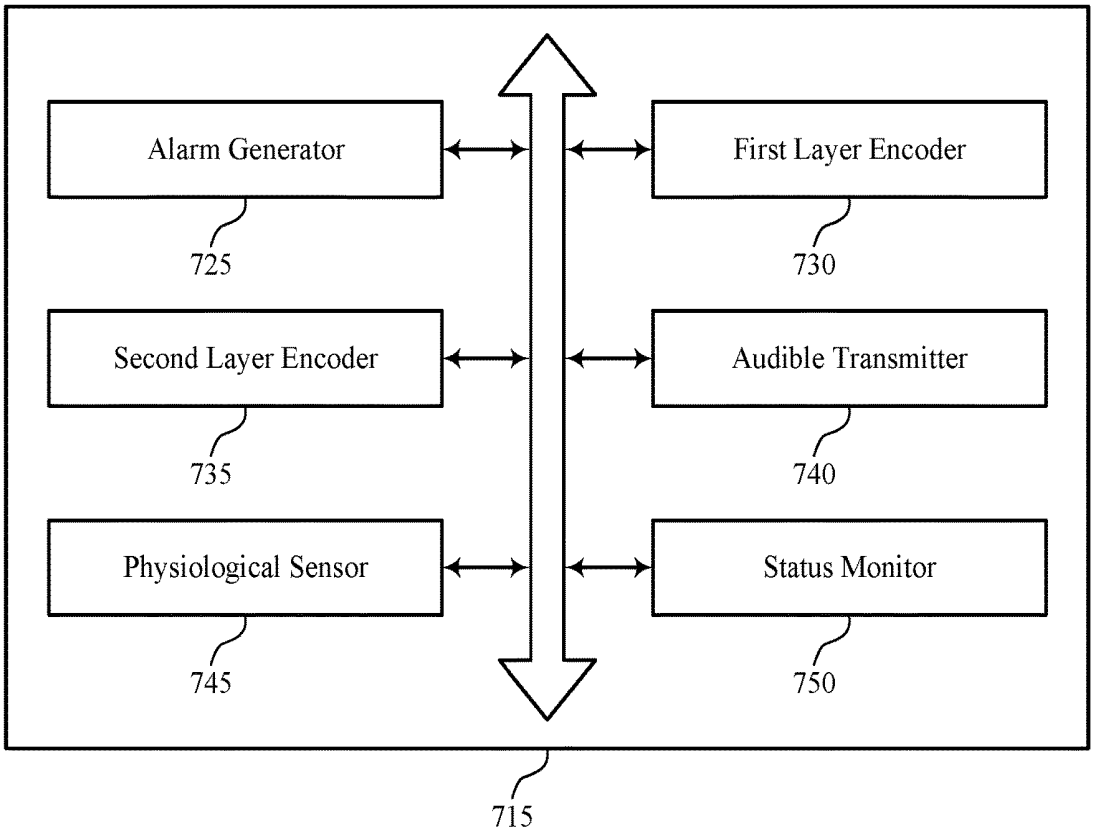

Alarm Generator
725
First Layer Encoder
730
Second Layer Encoder
735
Audible Transmitter
740
Physiological Sensor
745
Status Monitor
750
715

FIG. 7

700

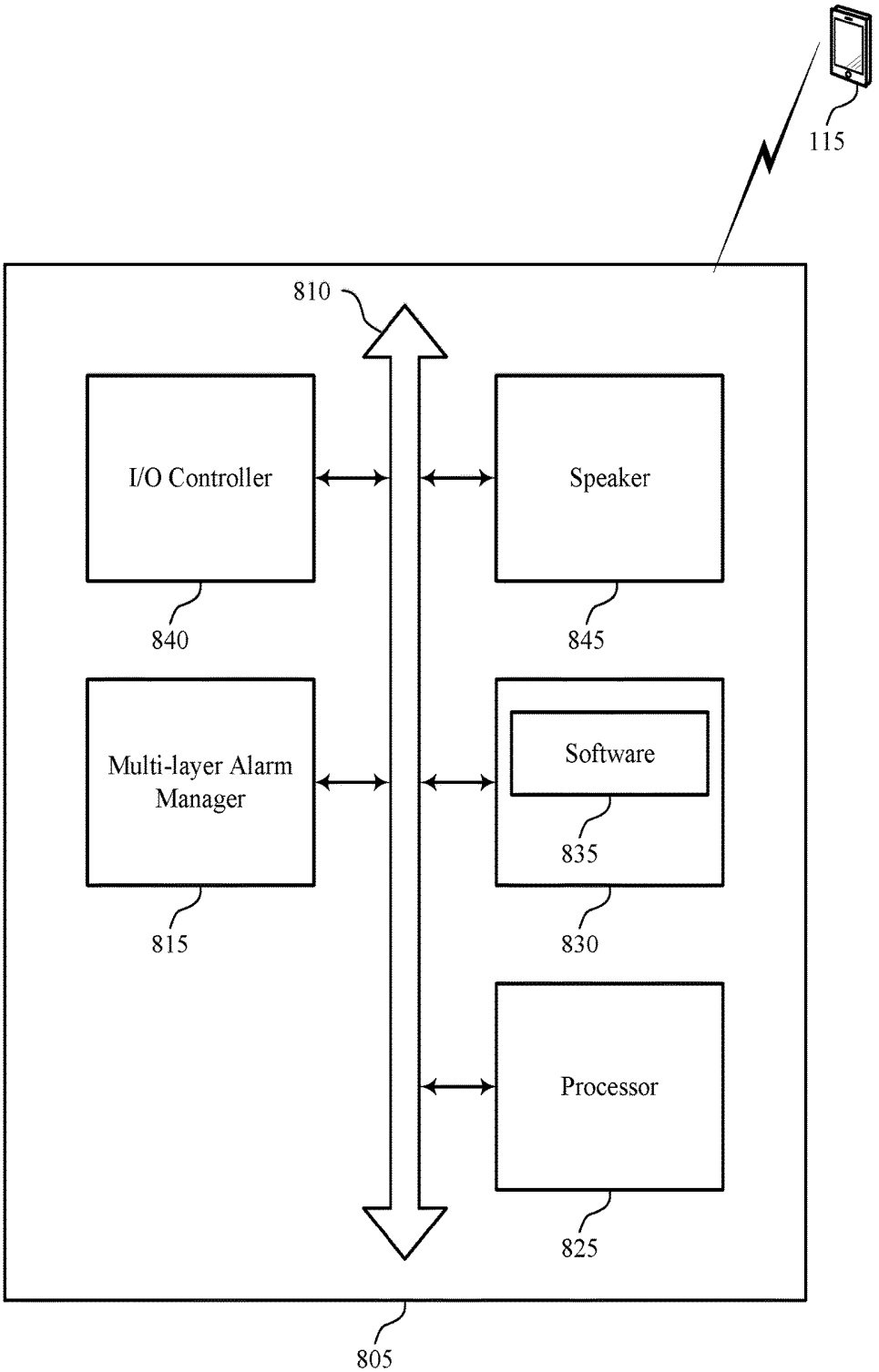

115
810
I/O Controller
Speaker
840
845
Multi-layer Alarm Manager
Software
835
815
830
Processor
825
805
800

FIG. 8

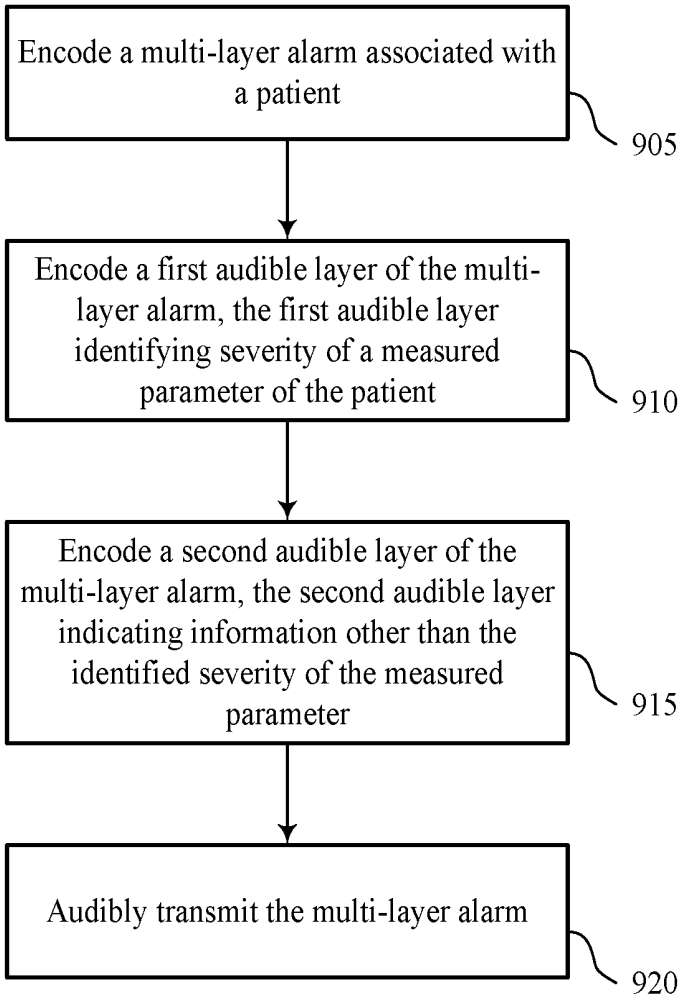

Encode a multi-layer alarm associated with a patient
905
Encode a first audible layer of the multi-layer alarm, the first audible layer identifying severity of a measured parameter of the patient
910
Encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter
915
Audibly transmit the multi-layer alarm
920
900

FIG. 9

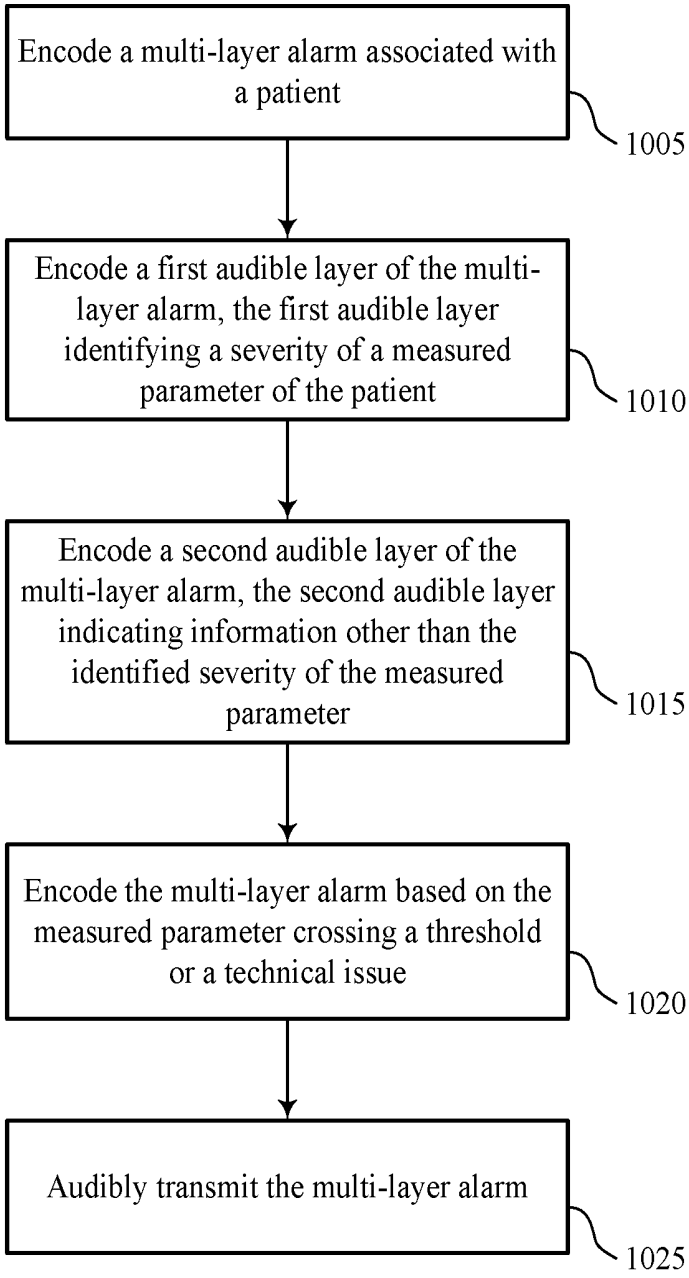

Encode a multi-layer alarm associated with a patient
1005
Encode a first audible layer of the multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient
1010
Encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter
1015
Encode the multi-layer alarm based on the measured parameter crossing a threshold or a technical issue
1020
Audibly transmit the multi-layer alarm
1025
1000

FIG. 10

MULTI-LAYER ALARMING

BACKGROUND

[0001] The following relates generally to alerting a clinician, and more specifically to multi-layer alarming.

[0002] In a healthcare facility such as a hospital, physiological parameters of the patient (e.g., heart rate, respiratory rate, blood pressure) may be monitored by one or more medical devices. The medical devices may be battery powered and may wirelessly transmit measured patient data over a wireless network within the hospital, thereby allowing the patient to move freely through the hospital while being monitored. Clinicians may remotely monitor the patient by accessing the patient data at a central nurse station or on any web enabled device connected to the network (e.g., smartphone or tablet). Other information related to the patient (e.g., location information, patient identification information, responsible clinician) may also be recorded and stored at a central nurse station or otherwise made available to clinicians.

[0003] When multiple patients are being monitored, alarms from several medical devices may be transmitted and sounded at a central nurse station or on a mobile device carried by a clinician. Because multiple alarms from multiple patients may be sounding simultaneously, it may be difficult for a clinician to discern relevant patient information or determine clinician responsibility simply by listening to the alarms. Also, the multiple alarms at the nurse station may contribute to alarm fatigue, because each clinician can hear all of the alarms, regardless of who is the responsible clinician or whether the alarm requires immediate attention. If the sounding alarm is urgent, any delay in responding to the alarm could put a patient or multiple patients at risk.

SUMMARY

[0004] The described features generally relate to methods and devices for alerting a clinician by sounding an alarm having multiple layers (i.e., a multi-layer alarm). Each layer of the multi-layer alarm may indicate certain information associated with a patient being monitored by one or more medical devices. For example, a first layer of the multi-layer alarm may identify a severity of a measured physiological parameter, such as heart rate, blood pressure, temperature, respiratory rate, activity level, or oxygen saturation level of the patient. A second layer of the multi-layer alarm may indicate other information such as a clinician responsible for the patient being monitored.

[0005] To alert a clinician, the multi-layer alarm may be audibly transmitted (e.g., using a speaker). Each layer of the multi-layer alarm may correspond with layer properties such as pitch, volume, and periodicity, which define each layer and different each layer from another layer of the multi-layer alarm.

[0006] Embodiments of systems and devices for multi-layer alarming are also described. In accordance with certain aspects, an apparatus for multi-layer alarming includes a processor, memory in electronic communication with the processor, and instructions stored in the memory. The instructions stored in the memory may be operable, when executed by the processor, to cause the apparatus to encode a multi-layer alarm associated with a patient, encode a first audible layer of the multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient, encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter, and audibly transmit the multi-layer alarm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** illustrates an example of a system for wireless patient monitoring that supports multi-layer alarming in accordance with aspects of the present disclosure.

[0008] FIG. **2** illustrates an example of a system for wireless patient monitoring that supports multi-layer alarming in accordance with aspects of the present disclosure.

[0009] FIG. **3** illustrates an example of a multi-layer alarm in accordance with aspects of the present disclosure.

[0010] FIGS. **4A-4D** illustrate examples of a multi-layer alarm in accordance with aspects of the present disclosure.

[0011] FIGS. **5** through **7** show block diagrams of a device that supports multi-layer alarming in accordance with aspects of the present disclosure.

[0012] FIG. **8** illustrates a block diagram of a system including a device that supports multi-layer alarming in accordance with aspects of the present disclosure.

[0013] FIGS. **9** and **10** illustrate methods for multi-layer alarming in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0014] In a healthcare facility, multiple alarms from several patients may be sounding at a central nurse station, each of which may pertain to different information of the patient. The alarms may be sound from a variety of different medical devices used to monitor the patient. In some cases, multiple medical devices may be used to monitor a single patient, each of which may sound an alarm based on certain criteria. For example, a medical device may be used to monitor the heart rate of a patient and may sound when the heart rate falls below a minimum threshold. Another medical device may be used to monitor the respiratory rate of the patient and may sound when the respiratory rate reaches a maximum threshold.

[0015] When multiple alarms are being sound from multiple medical devices monitoring a patient, the clinician(s) responsible for the patient may be unable to discern relevant information (such as whether the patient needs immediate attention) from the multiple alarms. Further, if a clinician or group of clinicians are responsible for monitoring multiple patients, it may also be difficult to discern which alarm corresponds to a particular patient when multiple alarms are being sound. However, by generating a multi-layer alarm in accordance with aspects of the present disclosure, a clinician or a group of clinicians monitoring one or more patients may be able to discern relevant information and responsibilities more quickly and accurately.

[0016] In one or more embodiments, the multi-layer may be encoded with multiple audible layers, each of which being associated with layer properties such as pitch, volume, and periodicity. Each layer of the multi-layer alarm may indicate information related to a patient being monitored. Once generated, the multi-layer alarm may be audibly transmitted in order to alert one or more clinicians of relevant information relating to the patient.

[0017] FIG. **1** illustrates an example of a wireless patient monitoring system **100** in accordance with various embodi-

ments of the present disclosure. The wireless patient monitoring system **100** may include a patient **105** wearing, carrying, or otherwise coupled with a medical device **110**. Although a single medical device **110** is shown, multiple medical devices **110** may be coupled to the patient **105**. The patient **105** may be a patient in a hospital, nursing home, home care, a medical facility, or another care facility. The medical device **110** may transmit signals via wireless communications links **150** to computing devices **115** or to a network **125**. In some cases, the medical device **110** may be used in conjunction with another medical device **110** to generate a multi-layer alarm.

[0018] Computing device **115**-*a* may be a wireless device such as a tablet, cellular phone, personal digital assistant (PDA), dedicated receiver, a wireless laptop computer, a mobile computer station or other similar device or a spatially distributed network of devices configured to receive signals from the medical device **110**. Computing device **115**-*b* may be an in-room patient monitoring device, a Workstation on Wheels, or a smart hospital bed which may be linked to the network **125** and medical device **110** using wireless links **150**. Computing device **115**-*b* may be configured to gather or receive data associated with the patient **105** using multiple sources and may also include a medical device **110** used to monitor parameters or collect data from the patient **105**. The computing devices **115** may be in communication with a central station **135** via network **125**.

[0019] The medical device **110** may also communicate directly with the central station **135** via the network **125**. The central station **135** may be a server located within the hospital or in a remote location and may be in communication with a nurse station **120** using wireless links **150**. The central station **135** may be in further communication with one or more remote computing devices **145**, thus allowing a clinician to remotely monitor the patient **105**. The central station **135** may also be in communication with various remote databases **140** where the collected patient data may be stored. In some cases, the remote databases **140** include electronic medical records (EMR) applications for storing and sharing patient data.

[0020] The medical device **110** may include one or more sensors configured to collect a variety of physiological parameters as well as information related to the location and movement of the patient **105**. For example, the medical device **110** may include a pulse oximetry (SpO2) sensor, a heart rate sensor, a blood pressure sensor, a pressure sensor, an electrocardiogram (ECG) sensor, a respiratory rate sensor, a glucose level sensor, a body temperature sensor, an accelerometer, a global positioning sensor, a sensor which triangulates position from multiple computing devices **115**, or any other sensor configured to collect physiological, location, or motion data.

[0021] The medical device **110** may be coupled with the patient **105** in a variety of ways depending on the data being collected. For example, the medical device **110** may be directly coupled with the patient **105** (e.g., physically connected to the patient's chest, worn around the patient's wrist, or attached to the patient's finger). The sensor may be indirectly coupled with the user so that movement of the patient **105** is detected even though the sensor is not in direct contact with, or physically connected to, the patient **105** (e.g., the medical device **110** may be disposed under the patient **105**). The data collected by the medical device **110** may be wirelessly conveyed to either the computing devices **115** or to the remote computing device **145** (via the network **125** and central station **135**). Data transmission may occur via, for example, frequencies appropriate for a personal area network (such as Bluetooth, Bluetooth Low Energy (BLE), or IR communications) or local (e.g., wireless local area network (WLAN)) or wide area network (WAN) frequencies such as radio frequencies specified by IEEE standards (e.g., IEEE 802.15.4 standard, IEEE 802.11 standard (Wi-Fi), IEEE 802.16 standard (WiMAX), etc.).

[0022] In accordance with various embodiments, the nurse station **120** may be used to monitor the patient **105** and may obtain data associated with the patient **105** from the medical device **110**. Data may also be obtained by the nurse station **120** from the network **125** or from the server **135** or remote databases **140** using wireless links **150** or may be obtained from the medical device **110** or computing devices **115**. The obtained data may then be displayed or otherwise accessible using the nurse station **120** so that nurses (or other clinicians) are able to monitor the patient **105** (and other patients).

[0023] The medical device **110** may be configured to trigger or sound an alarm based on certain criteria associated with the medical device and the patient. In some cases, the alarm is sound at the medical device **110** within the room of the patient **105**. Additionally or alternatively, the medical device **110** may trigger an alarm to be sent to a remote location (e.g., nurse station **120**), where the alarm is sound. The medical device **110** may monitor a physiological parameter of the patient such as heart rate, respiratory rate, blood pressure, etc., and may trigger or sound an alarm when the measure physiological parameter crosses a threshold. The medical device **110** may also sound an alarm based on a status of the medical device. For instance, if the medical device **110** experiences a technical issue such as a startup failure or has a low battery, an alarm may be triggered or sound.

[0024] In some aspects, the medical device **110**, the nurse station **120**, or the computing devices **115** may be configured to generate and/or audibly transmit a multi-layer alarm. For example, the nurse station **120** or the computing devices **115** may be linked to the medical device **110** and may sound a multi-layer alarm based on data received from the medical device **110**. In some embodiments, the multi-layer alarm may be sound at the nurse station **120** or the computing devices **115** in conjunction with or based on the alarm from the medical device **110**.

[0025] FIG. **2** illustrates an example of a wireless patient monitoring system **200** for multi-layer alarming. In some cases, the wireless patient monitoring system **200** may represent aspects of techniques performed by a computing devices **115**, medical devices **110**, or nurse station **120** as described with reference to FIG. **1**.

[0026] As shown in FIG. **2**, multiple patients **105** are located in different rooms **205** and may be monitored by one or more clinicians **210**. In FIG. **2**, patient **105**-*a* is located in room **205**-*a*, patient **105**-*b* is located in room **205**-*b*, patient **105**-*c* is located in room **205**-*c*, and patient **105**-*c* is located in room **205**-*c*. The rooms **205** may be located throughout a healthcare facility (e.g., each room may be on a different floor of a hospital) or may be located in different healthcare facilities remote from clinicians **210**. For example, patient **105**-*a* in room **205**-*a* may be located at home, patients **105**-*b* and **105**-*c* may be located in an intensive care area of a healthcare facility, and patient **105**-*d* may be located in room

205-*d* in a healthcare facility different from the other patients 105-*b* and 105-*c*, but in the same area (e.g., the same floor of a hospital) as nurse station 120-*a*.

[0027] Clinicians 210 may monitor patients 105 using medical devices 110, nurse station 120-*a*, or other devices such as computing device 115-*a*. Each patient 105 may be monitored by medical devices 110 connected to, or otherwise associated with, a patient 105. For example, medical device 110-*a* may be worn by patient 105-*a* to monitor heart rate of the patient 110-*a*. Medical device 110-*b* may not be directly attached to patient 105-*b*, but may indirectly measure movement of patient 110-*b*. Patient 105-*c* may be monitored by multiple medical devices 110-*c*, 110-*d*, and 110-*e*. As shown, medical device 110-*c* is directly attached to patient 105-*c* and may monitor a physiological parameter of the patient 105-*c*. Medical devices 110-*d* and 110-*e* may indirectly monitor other parameters of the patient 105-*c*. While each of medical devices 110-*c*, 110-*d*, and 110-*e* may measure different parameters of the patient 105-*c*, in some cases, medical devices 110-*c*, 110-*d*, and 110-*e* may be used in conjunction with one another to monitor one or more parameters associated with the patient 105-*c*. Patient 105-*d* may be monitored using medical devices 110-*f* and 110-*g*, each of which may be configured to monitor different parameters associated with the patient 105-*d* or may be used in conjunction with each other to monitor one or more parameters of the patient 105-*d*.

[0028] In some cases, medical devices 110 may be used in conjunction with other devices to monitor the patients 105. Medical devices 110 may wirelessly communicate with one another through network 125-*a* or may be directly connected to each other when monitoring patients 105. Medical devices 110 may also communicate with nurse station 120-*a* or computing device 115-*a* so that nurses 210 are able to monitor patients 105 from one location even though the patients 105 are in different locations. For example, medical devices 110 may transmit data to nurse station 120-*a* or computing devices 115-*a* via network 125-*a*. Alternatively, nurse station 120-*a* may request or retrieve data from one or more medical devices 110 without the medical devices 110 having to transmit the data. For example, data from a medical device 110 may be stored on the medical device 110 and may only be viewable by a responsible clinician 210. The responsible clinician 210 may then use nurse station 120-*a* to access or retrieve the data stored on medical device 110. The transmitted or retrieved data may then be viewable or otherwise accessible by clinicians 210 to monitor the patients 105.

[0029] The data from one or more medical devices 110 may include alarms that may be triggered when a parameter being measured by a medical device 110 crosses a threshold, for example. In some cases, the medical device 110 may sound an alarm or may transmit information to the nurse station 120-*a* or computing device 115-*a* triggering the nurse station 120-*a* or computing device 115-*a* to also sound an alarm. The thresholds for sounding an alarm may be patient specific in that each patient 105 may be associated with different thresholds for different medical devices 110 used to monitor the patient 105. For example, patient 105-*a* may be in room 205-*a* at home and may be relatively active compared to patient 105-*c* in intensive care. Therefore, the heart rate of patient 105-*a* monitored by medical device 110-*a* may have a relatively high threshold for sounding (or triggering) an alarm compared to the threshold for an alarm associated with patient 205-*c* (monitored by medical device 110-*c*, for example).

[0030] In one or more embodiments, nurse station 120-*a* may obtain data from medical devices 110 for monitoring patients 105. The nurse station 120-*a* may sound an alarm based on information received or obtained from medical devices 110. Further, multiple alarms may be sound from the nurse station 120-*a* for each patient 105 or for multiple patients 105. For example, data from medical device 110-*a* may cross a threshold for patient 105-*a* and an alarm 220-*a* may be sound from nurse station 120-*a*. In addition, data from medical devices 110-*c* and 110-*d* may also cross a threshold for patient 105-*c*, and an alarm 220-*b* (or multiple alarms associated with each medical device 110-*c* and 110-*d*) may be sound from nurse station 120-*a*. Medical device 110-*g* monitoring patient 105-*d* may also sound an alarm 220-*c* from room 205-*d*, which is in the same area as nurse station 120-*a*. Computing device 115-*a* may be a mobile computing device 115-*a* for clinician 210-*b* and may communicate with medical devices 110 or nurse station 120-*a*. In some cases, computing device 115-*a* may also sound an alarm 220-*d* based on one or more medical devices 110 or the alarms 220-*a* or 220-*b* from nurse station 120-*a*. In such situations, multiple alarms 220 from multiple sources (nurse station 120-*a*, room 205-*d*, computing device 115-*a*, etc.) may be sound at the same time which may lead to clinicians 210 having difficulty discerning relevant information from each of the alarms 220.

[0031] Additionally, while each of clinicians 210-*a*, 210-*b*, and 210-*c* may be responsible for monitoring each patient 105, in some cases, certain clinicians 210 may be responsible for only certain patients 105 or medical devices 110. Clinician 210-*a* may be a cardiologist and may be responsible for monitoring the heart rate of each patient 105 and may therefore not be concerned with alarms 220 (or medical devices 110) that are not related to heart rate of the patients 105. Clinician 210-*b* may only be responsible for patient 105-*b* (e.g., in intensive care) and may therefore not be concerned with alarms 220 associated with other patients 105-*a*, 105-*c*, and 105-*d*. Clinician 210-*c* may only be responsible for local patients, such as patient 105-*d* located in room 205-*d* in the same area as nurse station 120-*a*. Accordingly, as different clinicians 210 have different responsibilities, multiple sounding alarms 220 may not always be beneficial to each clinician 210 and could possibly cause clinicians 210 to naturally tune out multiple sounding alarms 220, not pay attention to most alarms 220, or have difficulty in determining whether an alarm 220 requires immediate attention by a certain clinician 210. The multiple sounding alarms 220 heard by multiple clinicians 210 who may not be responsible for responding to certain alarms 220 may lead to alarm fatigue for the clinicians 210.

[0032] In accordance with the present disclosure, a multi-layer alarm 220 may be generated having multiple audible layers of information related to the alarm 220, the patient 105, or the clinician responsible 210 for the patient 105. Each audible layer of the multi-layer alarm 220 may have corresponding layer properties which may include one or more of pitch, volume, and periodicity. Pitch may refer to the frequency of the acoustic wave associated with the layer when the multi-layer alarm is audibly transmitted. Volume may refer to the amplitude of the acoustic wave associated with the layer when the multi-layer alarm is audibly trans-

mitted, and periodicity may refer to the number of times the acoustic wave is to be transmitted over a specific time interval.

[0033] The multi-layer alarm **220** may be generated by medical devices **110**, nurse station **120**-*a*, or computing device **115**-*a*. A first audible layer of the multi-layer alarm may include information related to a measured parameter associated with a patient **105**. For example, the first audible layer of the multi-layer alarm may identify the parameter of the patient **105** being measured by a medical device **110**. For example, the first audible layer of the multi-layer alarm may indicate that the parameter of the patient **105** being monitored is a physiological parameter such as respiratory rate. The first audible layer may additionally, or alternatively, indicate the severity of the physiological parameter being measured based on the importance of the parameter (e.g., respiratory rate may be more severe than heart rate). In some cases, physiological parameters may be grouped into different severity categories based on how important the physiological parameter is to the health of the patient **105**. For example, respiratory rate and heart rate may be grouped into a high severity category, oxygen saturation and temperature may be grouped into a medium severity category, and activity level may be grouped into a low severity category. In such instances, the first audible layer may indicate the severity of the physiological parameter and whether or not the physiological parameter is of high, medium, or low severity. The grouping of the physiological parameters may depend on the patient **105**, the health of the patient **105**, and the current condition or procedure in which the patient **105** is undergoing or has previously undergone. As such, different parameters may be grouped into different severity categories and other groupings of parameters may be considered without departing from the scope of the present disclosure.

[0034] In some embodiments, each of the physiological parameters within a severity group may have corresponding alarm thresholds of different criticalities (e.g., low criticality, medium criticality, and high criticality). For example, a medium severity physiological parameter, e.g., temperature, may be associated with a low criticality alarm threshold indicating that the temperature is slightly abnormal, but the patient **105** may not require immediate attention. The temperature may also be associated with a medium criticality alarm threshold indicating that the measured temperature is more abnormal (or worsening) and the patient **105** may soon require attention. Further, the temperature may also be associated with a high criticality alarm threshold and should the measured temperature reach the high criticality alarm threshold, the patient **105** may need immediate attention.

[0035] In some cases, a physiological parameter may be included in multiple severity categories based on the criticality of the alarm threshold corresponding the physiological parameter. For example, a physiological parameter such as heart rate may be associated with a low criticality alarm threshold, a medium criticality alarm threshold, and a high criticality alarm threshold. Heart rate along with a corresponding high criticality alarm threshold may be grouped into a high severity category, while the heart rate along with corresponding low and medium criticality alarm threshold may be grouped into a medium severity category. In another example, temperature may be associated with a high criticality alarm threshold and a low criticality alarm threshold and may be grouped based on the criticality of the alarm threshold. For instance, temperature along with a corresponding high criticality alarm threshold may be grouped into a high severity category, while temperature along with a corresponding low criticality alarm threshold may be grouped into a low severity category. Other groupings and corresponding criticalities of alarm thresholds associated with a measured physiological parameter may be considered without departing from the scope of the present disclosure.

[0036] A second audible layer of the multi-layer alarm may indicate other information associated with the medical device **110** or the patient **105**, such as the clinician responsible for the patient **105**, or the medical device **110** that triggered the alarm, or how long the patient **105** has been unattended. In some embodiments, the second audible layer of the multi-layer alarm may indicate that the measured physiological parameter has reached a particular alarm threshold (e.g., a low criticality alarm threshold, a medium criticality alarm threshold, or a high criticality alarm threshold). For example, the first audible layer of the multi-layer alarm may indicate severity of the measured physiological parameter, while the second audible layer of the multi-layer alarm may indicate the criticality of the measured physiological parameter. Thus, severity of the measured physiological parameter and the criticality of the measured physiological parameter may be indicated by the first and second audible layers of the multi-layer alarm.

[0037] In some instances, the severity and criticality of a physiological parameter may be indicated in a single audible layer. For example, a first audible layer may include layer properties (e.g., volume, pitch, periodicity) that indicates both the severity of the physiological parameter being measured and the criticality associated with the measured physiological parameter.

[0038] The multi-layer alarm may be sound at a medical device **110** associated with the alarm, at the nurse station **120**-*a*, or at the computing device **115**-*a*. The multi-layer alarm may then be repeated over a given time period. As the multi-layer alarm is generated with audible layers of information relating to the patient **105**, the clinicians **210** may hear the multi-layer alarm and may be able to quickly discern relevant information (e.g., the severity of the alarm, the criticality of the alarm, which clinician **210** is responsible, whether the patient **105** requires immediate attention) related to the medical device **110**, the parameter being measured, the patient, or the responsible clinician **210**.

[0039] FIG. **3** illustrates an example of a multi-layer alarm **300** in accordance with aspects of the present disclosure. In some cases, the multi-layer alarm **300** may represent aspects of techniques performed by a medical device **110**, computing device **115**, or nurse station **120** as described with reference to FIGS. **1** and **2**. For example, a medical device **110**, a computing device **115**, or a nurse station **120** may audibly transmit multi-layer alarm **300**.

[0040] In FIG. **3**, the multi-layer alarm **300** includes multiple audible layers **305** and spans a time period **310**. Each of the multiple audible layers **305** span a corresponding time interval **315**. Though the multi-layer alarm **300** spans time period **310**, the multi-layer alarm **300** may be repeated when audibly transmitted over a given duration. For example, if time period **310** is ten seconds, the multi-layer alarm **300** may repeat six times over a one minute duration. Alternatively, the multi-layer alarm **300** may intermittently repeat over a duration (e.g., one time, two times, or three times over a one minute duration). The repetitions

of multi-layer alarm **300** may be equally spaced over a duration or may be spaced differently over the duration. While a time period of ten seconds and a duration of one minute is described herein, any other time periods or durations may be considered without departing from the scope of the present disclosure.

[0041] Each layer **305** may indicate or identify information related to a patient such as a measured parameter, severity of the measured parameter, or a clinician responsible for the patient. In addition, each layer **305** may have corresponding layer properties such as pitch, volume, and periodicity to uniquely define or indicate such information and distinguish it from another layer **305**. For example, layer **305**-*a* may correspond with a given pitch and volume, but may not be repeated over the time period **310** (i.e., no periodicity). Layer **305**-*a* may identify a measured parameter of the patient such as a physiological parameter or a severity of the measured parameter of the patient.

[0042] In one or more embodiments, multiple layers **305** may be used to indicate or identify information related to a patient. For example, layers **305**-*b* and **305**-*c* may each have corresponding layer properties that collectively may be used to indicate a measured parameter of the patient or a clinician responsible for the patient. In another example, layers **305**-*d*, **305**-*e*, **305**-*f*, and **305**-*g* may have the same pitch and volume properties and may repeat over time period **310** (i.e., periodic). In some cases, the time interval **315** over which a layer **305** spans may vary depending on the layer **305**. For example, layers **305**-*h* and **305**-*i* span different time intervals compared to other layers **305** of the multi-layer alarm **300** and may repeat twice over time period **310**.

[0043] FIGS. **4**A-**4**D illustrate examples of multi-layer alarms **400** in accordance with aspects of the present disclosure. In some cases, the multi-layer alarms **400** may represent aspects of techniques performed by a medical device **110**, computing device **115**, or nurse station **120** as described with reference to FIGS. **1** and **2**. For example, a medical device **110**, a computing device **115**, or a nurse station **120** may audibly transmit multi-layer alarms **400**.

[0044] In FIG. **4**A, a multi-layer alarm **400**-*a* is shown spanning time period T**1** and includes layers **405**-*a*, **405**-*b*, and **405**-*c*. Each of the layers **405**-*a*, **405**-*b*, and **405**-*c* may indicate information associated with a patient being monitored by a medical device (e.g., medical device **110**) and include corresponding layer properties such as pitch and periodicity. As shown, layer **405**-*a* has a pitch P**1** and is continuous over time period T**1**. Layer **405**-*b* has a pitch P**2** and repeats twice over time period T**1**. However, layer **405**-*b* begins after a delay. Layer **405**-*c* has a pitch P**3** and repeats thirteen times over time period T**1**. In some embodiments, two or more of layers **405**-*a*, **405**-*b*, and **405**-*c* may collectively indicate information associated with the patient. For example, layer **405**-*a* may indicate the responsible clinician for a particular patient, layer **405**-*b* may indicate the physiological parameter that triggered the alarm, and layer **405**-*c* may indicate where the patient is located within the healthcare facility.

[0045] In FIG. **4**B, a multi-layer alarm **400**-*b* is shown spanning time period T**2** and includes layers **405**-*d*, **405**-*e*, and **405**-*f*. Each of the layers **405**-*d*, **405**-*e*, and **405**-*f* may indicate information associated with a patient being monitored by a medical device (e.g., medical device **110**) and include corresponding layer properties such as pitch and periodicity. As shown, layer **405**-*d* has a pitch P**4** and repeats twelve times over time period T**2**, but begins after a delay. Layer **405**-*e* has a pitch P**5** and repeats twice over time period T**2**, but ends with a delay. Layer **405**-*f* has a pitch P**6** and repeats six times over time period T**2** and also begins after a delay. In some embodiments, two or more of layers **405**-*d*, **405**-*e*, and **405**-*f* may collectively indicate information associated with the patient. For example, layer **405**-*d* may indicate the physiological parameter that triggered the alarm, layer **405**-*e* may indicate that the measured physiological parameter has escalated recently (e.g., the measured parameter or overall condition of the patient was worsened), and layer **405**-*f* may indicate the clinician responsible for the patient.

[0046] In FIG. **4**C, a multi-layer alarm **400**-*c* is shown spanning time period T**3** and includes layers **405**-*g*, **405**-*h*, **405**-*i* and **405**-*j*. Each of the layers **405**-*g*, **405**-*h*, **405**-*i* and **405**-*j* may indicate information associated with a patient being monitored by a medical device (e.g., medical device **110**) and include corresponding layer properties such as volume and periodicity. As shown, layer **405**-*g* has a volume V**1** and is continuous after a delay over time period T**3**. Layer **405**-*h* has a Volume V**2** and repeats twice over time period T**3**, but begins with a delay. Layer **405**-*i* has a volume V**3** and repeats five times over time period T**3** but ends with a delay. Layer **405**-*j* has a volume V**4** and repeats six times over time period T**3** but ends with a delay. In some embodiments, two or more of layers **405**-*g*, **405**-*h*, **405**-*i* and **405**-*j* may collectively indicate information associated with the patient. For example, layer **405**-*g* may indicate the severity (e.g., high, medium, or low severity) associated with the alarm, layer **405**-*h* may indicate the clinician responsible for the patient, layer **405**-*i* may indicate that the patient has been left unattended for a certain amount of time, and layer **405**-*j* may indicate the device type that triggered the alarm.

[0047] In FIG. **4**D, a multi-layer alarm **400**-*d* is shown spanning time period T**4** and includes layers **405**-*k* and **405**-**1**. Each of the layers **405**-*k* and **405**-**1** may indicate information associated with a patient being monitored by a medical device (e.g., medical device **110**) and include corresponding layer properties such as volume and periodicity. As shown, layer **405**-*k* has a volume V**5** and repeats twelve times over time period T**4**, but begins with a delay. Layer **405**-**1** has a volume V**6** and repeats three times over time period T**4** but begins and ends with a delay. In some embodiments, layers **405**-*k* and **405**-**1** may collectively indicate information associated with the patient. For example, layer **405**-*k* may indicate the severity (e.g., high, medium, or low severity) or the criticality associated with a physiological parameter that triggered the alarm, and layer **405**-**1** may indicate location of the patient.

[0048] FIG. **5** shows a block diagram **500** of a device **505** that supports multi-layer alarming in accordance with various aspects of the present disclosure. Device **505** may be an example of aspects of a medical device **110**, computing device **115**, or nurse station **120**, as described with reference to FIGS. **1** and **2**.

[0049] As shown, device **505** may include input **510**, multi-layer alarm manager **515**, and output **520**. Device **505** may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0050] Multi-layer alarm manager **515** may encode a multi-layer alarm associated with a patient. The multi-layer alarm manager **515** may encode a first audible layer of the

multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient and encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter. The multi-layer alarm manager **515** may also audibly transmit the multi-layer alarm. In some embodiments, multi-layer alarm manager **515** may be an example of aspects of the multi-layer alarm manager **815** described with reference to FIG. **8**.

[0051] FIG. **6** shows a block diagram **600** of a device **605** that supports multi-layer alarming in accordance with various aspects of the present disclosure. Device **605** may be an example of aspects of a device **505** or a medical device **110** as described with reference to FIGS. **1**, **2** and **5**. Device **605** may include input **610**, multi-layer alarm manager **615**, and output **620**. Device **605** may also include a processor. Each of these components may be in communication with one another (e.g., via one or more buses).

[0052] Multi-layer alarm manager **615** may include alarm generator **625**, first layer encoder **630**, second layer encoder **635**, and audible transmitter **640**. Alarm generator **625** may encode a multi-layer alarm associated with a patient. In one or more embodiments, encoding the multi-layer alarm is based on a measured parameter (e.g., measured by a medical device **110**) crossing a threshold. In some cases, encoding the multi-layer alarm may be based on a status or a technical issue associated with device **605** or other device (e.g., medical device **110**, nurse station **120**, computing device **115**). In some cases, encoding the multi-layer alarm includes determining one or more layer properties for each audible layer of the multi-layer alarm such as a volume, a pitch, or a periodicity.

[0053] First layer encoder **630** may encode a first audible layer of the multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient. The first layer audible layer may be uniquely defined by one or more layer properties to identify the severity of the measure parameter of the patient.

[0054] Second layer encoder **635** may encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter. In some cases, the information other than the identified severity of the measured parameter includes a clinician responsible for the patient or a duration of alarm transmission without clinician intervention. In one or more embodiments, the second audible layer may include an escalation level associated with the measured parameter, a device type associated with measuring the measured parameter, or a technical issue of a medical device (e.g., medical device **110**) associated with the patient. The second audible layer may also indicate a patient location or a criticality of the measured physiological parameter.

[0055] Audible transmitter **640** may audibly transmit the multi-layer alarm. In some cases, audibly transmitting the multi-layer alarm may include audibly transmitting both the first and second audible layers contemporaneously or sequentially or periodically over a given time interval.

[0056] In one or more embodiments, multi-layer alarm manager **615** may be an example of aspects of the multi-layer alarm manager **815** described with reference to FIG. **8**.

[0057] FIG. **7** shows a block diagram **700** of a multi-layer alarm manager **715** that supports multi-layer alarming in accordance with various aspects of the present disclosure. The multi-layer alarm manager **715** may be an example of aspects of a multi-layer alarm manager **515**, a multi-layer alarm manager **615**, or a multi-layer alarm manager **815** described with reference to FIGS. **5**, **6**, and **8**. The multi-layer alarm manager **715** may include alarm generator **725**, first layer encoder **730**, second layer encoder **735**, and audible transmitter **740**. Each of these modules may communicate, directly or indirectly, with one another (e.g., via one or more buses).

[0058] Alarm generator **725** may encode a multi-layer alarm associated with a patient. In one or more embodiments, encoding the multi-layer alarm is based on a measured parameter (e.g., measured by a medical device **110**) crossing a threshold. In some cases, encoding the multi-layer alarm may be based on a status or a technical issue associated with a device (e.g., medical device **110**, nurse station **120**, computing device **115**). In some cases, encoding the multi-layer alarm includes determining one or more layer properties for each audible layer of the multi-layer alarm such as a volume, a pitch, or a periodicity.

[0059] First layer encoder **730** may encode a first audible layer of the multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient. The first layer audible layer may be uniquely defined by one or more layer properties to identify the severity of the measured parameter of the patient.

[0060] Second layer encoder **735** encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter. In some cases, the information other than the identified severity of the measured parameter includes a clinician responsible for the patient or a duration of alarm transmission without clinician intervention. In one or more embodiments, the second audible layer may include an escalation level associated with the measured parameter, a device type associated with measuring the measured parameter, or a technical issue of a medical device (e.g., medical device **110**) associated with the patient. The second audible layer may also indicate a patient location or a criticality of the measured parameter.

[0061] Audible transmitter **740** may audibly transmit the multi-layer alarm. In some cases, audibly transmitting the multi-layer alarm may include audibly transmitting both the first and second audible layers contemporaneously or sequentially or periodically over a given time interval.

[0062] Physiological sensor **745** may measure a parameter of the patient (e.g., using medical device **110**). In some cases, the measured parameter includes a physiological parameter of the patient such as a heart rate, a respiratory rate, a blood pressure, a temperature, an activity level, or an oxygen saturation level.

[0063] Status monitor **750** may determine a status of one or more devices (e.g., medical device **110**, nurse station **120**, or computing device **115**). For example, the status monitor **750** may determine a low battery indication associated with the device or a loss of power to the device. The status monitor **750** may also determine a self-test failure associated with the device, a startup failure of the device, or other technical issue associated with the device.

[0064] FIG. **8** shows a diagram of a system **800** including a device **805** that supports multi-layer alarming in accordance with various aspects of the present disclosure. Device **805** may be an example of a device **505**, device **605**, a

medical device **110**, nurse station **120**, or computing device **115**, as described above, e.g., with reference to FIGS. **1**, **2**, **5**, and **6**.

[0065] Device **805** may include components for bi-directional voice and data communications or components for transmitting and receiving communications. Device **805** may also include multi-layer alarm manager **815**, processor **825**, memory **830**, software **835**, I/O controller **840**, and speaker **845**.

[0066] Processor **825** may include an intelligent hardware device, (e.g., a central processing unit (CPU), a microcontroller, an application specific integrated circuit (ASIC), etc.)

[0067] Memory **830** may include random access memory (RAM) and read only memory (ROM). The memory **830** may store computer-readable, computer-executable software **835** including instructions that, when executed, cause the processor to perform various functions described herein. In some cases, the memory **830** may contain, among other things, a Basic Input-Output system (BIOS) which may control basic hardware and/or software operation such as the interaction with peripheral components or devices.

[0068] Software **835** may include code to implement aspects of the present disclosure, including code to support multi-layer alarming. Software **835** may be stored in a non-transitory computer-readable medium such as system memory or other memory. In some cases, the software **835** may not be directly executable by the processor but may cause a computer (e.g., when compiled and executed) to perform functions described herein.

[0069] I/O controller **840** may manage input and output signals for device **805**. In some cases, I/O controller **840** may utilize an operating system such as iOS®, ANDROID®, MS-DOS®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system.

[0070] Speaker **845** may audibly transmit an alarm from device **805**. In some cases, the speaker **845** may audibly transmit a multi-layer alarm having multiple layers, each associated with different layer properties, as described above with reference to FIGS. **3** and **4**A-**4**D.

[0071] FIG. **9** shows a flowchart illustrating a method **900** for multi-layer alarming in accordance with various aspects of the present disclosure. The operations of method **900** may be implemented by a device (e.g., medical device **110**, nurse station **120**, computing device **115**), or its components as described herein. For example, the operations of method **900** may be performed by a multi-layer alarm manager as described with reference to FIGS. **5** through **7**. In some examples, a device may execute a set of codes to control the functional elements of the device to perform the functions described below. Additionally or alternatively, the device may perform aspects the functions described below using special-purpose hardware.

[0072] At block **905**, the device may encode a multi-layer alarm associated with a patient. The operations of block **905** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **905** may be performed by an alarm generator as described with reference to FIGS. **5** through **7**.

[0073] At block **910**, the device may encode a first audible layer of the multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient. The operations of block **910** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **910** may be performed by a first layer encoder as described with reference to FIGS. **5** through **7**.

[0074] At block **915**, the device may encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter. The operations of block **915** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **915** may be performed by a second layer encoder as described with reference to FIGS. **5** through **7**.

[0075] At block **920**, the device may audibly transmit the multi-layer alarm. The operations of block **920** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **920** may be performed by an audible transmitter as described with reference to FIGS. **5** through **7**.

[0076] FIG. **10** shows a flowchart illustrating a method **1000** for multi-layer alarming in accordance with various aspects of the present disclosure. The operations of method **1000** may be implemented by a device (e.g., medical device **110**, nurse station **120**, or computing device **115**) or its components as described herein. For example, the operations of method **1000** may be performed by a multi-layer alarm manager as described with reference to FIGS. **5** through **7**. In some examples, a device may execute a set of codes to control the functional elements of the device to perform the functions described below. Additionally or alternatively, the device may perform aspects the functions described below using special-purpose hardware.

[0077] At block **1005**, the device may encode a multi-layer alarm associated with a patient. The operations of block **1005** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **1005** may be performed by an alarm generator as described with reference to FIGS. **5** through **7**.

[0078] At block **1010**, the device may encode a first audible layer of the multi-layer alarm, the first audible layer identifying a severity of a measured parameter of the patient. The operations of block **1010** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **1010** may be performed by a first layer encoder as described with reference to FIGS. **5** through **7**.

[0079] At block **1015**, the device may encode a second audible layer of the multi-layer alarm, the second audible layer indicating information other than the identified severity of the measured parameter. The operations of block **1015** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **1015** may be performed by a second layer encoder as described with reference to FIGS. **5** through **7**.

[0080] At block **1020**, the device may encode the multi-layer alarm is based on the measured parameter crossing a threshold or a technical issue. The operations of block **1020** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **1020** may be performed by an alarm generator as described with reference to FIGS. **5** through **7**.

[0081] At block **1025**, the device may audibly transmit the multi-layer alarm. The operations of block **1025** may be performed according to the methods described with reference to FIGS. **2** through **4**. In certain examples, aspects of the operations of block **1025** may be performed by an audible transmitter as described with reference to FIGS. **5** through **7**.

[0082] It should be noted that the methods described above describe possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Furthermore, aspects from two or more of the methods may be combined.

[0083] The description set forth herein, in connection with the appended drawings, describes example configurations and does not represent all the examples that may be implemented or that are within the scope of the claims. The term "exemplary" used herein means "serving as an example, instance, or illustration," and not "preferred" or "advantageous over other examples." The detailed description includes specific details for the purpose of providing an understanding of the described techniques. These techniques, however, may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the described examples.

[0084] In the appended figures, similar components or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If just the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

[0085] Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0086] The various illustrative blocks and modules described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a digital signal processor (DSP), an ASIC, an field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration). A processor may in some cases be in electronic communication with a memory, where the memory stores instructions that are executable by the processor. Thus, the functions described herein may be performed by one or more other processing units (or cores), on at least one integrated circuit (IC). In various examples, different types of ICs may be used (e.g., Structured/Platform ASICs, an FPGA, or another semi-custom IC), which may be programmed in any manner known in the art. The functions of each unit may also be implemented, in whole or in part, with instructions embodied in a memory, formatted to be executed by one or more general or application-specific processors.

[0087] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described above can be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations. Also, as used herein, including in the claims, "or" as used in a list of items (for example, a list of items prefaced by a phrase such as "at least one of" or "one or more of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C).

[0088] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that can be accessed by a general purpose or special purpose computer. By way of example, and not limitation, non-transitory computer-readable media can comprise RAM, ROM, electrically erasable programmable read only memory (EEPROM), compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that can be used to carry or store desired program code means in the form of instructions or data structures and that can be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, include CD, laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above are also included within the scope of computer-readable media.

[0089] The description herein is provided to enable a person skilled in the art to make or use the disclosure. Various modifications to the disclosure will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described

herein, but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

1-14. (canceled)

15. The system of claim **25**, wherein the measured physiological parameter of the patient comprises a heart rate, a respiratory rate, a blood pressure, a temperature, an activity level, or an oxygen saturation level.

16. The system of claim **25**, wherein the multi-layer alarm manager is further configured to:

encode the multi-layer alarm data structure based at least in part on a measured physiological parameter crossing one or more thresholds or technical issues of one or more medical devices;

encode a single data layer with one or more layer properties that correspond to one or more thresholds and groupings for a measured physiological parameter; and

encode a single data layer with one or more layer properties that correspond to patient information and technical issues from one or more medical devices.

17. The system of claim **16**, wherein the technical issues comprise a low battery indication associated with the medical device, a loss of power to the medical device, a self-test failure associated with the medical device, or a startup failure of the medical device.

18. The system of claim **25**, wherein the multi-layer alarm manager is further configured to:

generate one or more layer properties for each of the at least two data layers of the multi-layer alarm data structure, wherein one or more layer properties define and differentiate each data layer from another data layer of the multi-layer alarm.

19-21. (canceled)

22. The system of claim **25**, wherein the encoded information of the at least two data layers comprises a clinician responsible for the patient, a duration of alarm transmission without clinician intervention, an escalation level associated with the measured physiological parameter, a device type associated with measuring the measured physiological parameter, a technical issue of a medical device associated with the patient, a criticality of the measured physiological parameter, or a patient location.

23. (canceled)

24. The system of claim **25**, wherein audibly transmitting the multi-layer alarm data structure comprises:

audibly transmitting the first data layer after audibly transmitting subsequent data layers.

25. A system for alerting a clinician, comprising:

a multi-layer alarm manager configured to generate a transmittable multi-layer alarm data structure, the multi-layer alarm data structure comprising at least two data layers of encoded information related to a patient, each of the at least two data layers comprising one or more layer properties, the one or more layer properties comprising pitch, volume and periodicity, the first layer of the at least two data layers corresponding to a patient's measured physiological parameter, the second layer of the at least two data layers corresponding to a medical device, wherein the at least two data layers are configured to be sounded by an alarm generator simultaneously to generate an audibly transmitted alarm.

26. The system of claim **16**, wherein the groupings comprise:

criticality and severity of a measured physiological parameter, based on the importance of the particular physiological parameter to a specific patient.

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专利名称(译)	多层报警		
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摘要(译)

描述了用于无线患者监测的方法，系统和设备。所述方法，系统和设备提供具有多个层的多层警报，所述多个层指示与由医疗设备监视的患者相关联的信息。多层警报可以用至少两层信息编码，一层指示与患者的测量参数的严重性相关的信息，第二层指示与患者相关的其他信息。可以可听地发送多层警报，从而允许临床医生被警告与被监测的患者有关的相关信息。