(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 906 104 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
08.06.2016 Bulletin 2016/23

(21) Application number: **13785655.5**

(22) Date of filing: **03.10.2013**

(51) Int Cl.:
A61B 5/00 *(2006.01)* ***A61B 5/08*** *(2006.01)*
A61B 5/022 *(2006.01)*

(86) International application number:
PCT/IB2013/059091

(87) International publication number:
WO 2014/057399 (17.04.2014 Gazette 2014/16)

(54) **SYSTEM AND METHOD FOR BREATHING RATE MEASUREMENTS**

SYSTEM UND VERFAHREN FÜR ATEMFREQUENZMESSUNGEN

SYSTÈME ET PROCÉDÉ DE MESURES DE RYTHME DE LA RESPIRATION

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **09.10.2012 US 201261711290 P**

(43) Date of publication of application:
19.08.2015 Bulletin 2015/34

(73) Proprietor: **Koninklijke Philips N.V.**
5656 AE Eindhoven (NL)

(72) Inventor: **MÜHLSTEFF, Jens**
NL-5656 AE Eindhoven (NL)

(74) Representative: **Coops, Peter**
Philips Intellectual Property & Standards
High Tech Campus 5
5656 AE Eindhoven (NL)

(56) References cited:
US-A- 3 527 197
US-A1- 2006 074 283
US-A1- 2006 100 530
US-A1- 2012 197 128

EP 2 906 104 B1

Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] This invention belongs to the field of measurement and monitoring of breathing rate of a human subject.

BACKGROUND OF THE INVENTION

[0002] A number of physiological parameters are measured to estimate the state of health of a person. In the case of a patient in a hospital and especially in an intensive care unit (ICU) physiological parameters are measured on a continuous basis to monitor variations in the state of health of the patient. This is done to ensure timely medical intervention in case of deterioration in the state of health, especially when the deterioration is likely to endanger life.

[0003] One of the important parameters measured is the breathing rate, also called the respiratory rate. The most commonly used method in low acuity settings is to observe the rise and fall of the patient's chest during breathing and counting the number of inhalation and exhalation cycles, timed with a clock. This is problematic when the patient has irregular or shallow breaths due to breathing distress.

[0004] Devices and methods to automatically measure the breathing rate are known in the field, using different types of transducers. Some of those methods are impedance plethysmography, capnography (mainly used in ICUs) and inductive thoracic plethysmography (Respiband ™) in sleep studies (polysomnography). All these methods require the positioning of the sensor on the patient's body or elsewhere by a trained person.

[0005] The published patent application US20100222687, assigned to the same assignee as that of the present application discloses a method of using a plurality of Doppler radars disposed on the seat belt or integrated into the seat belt for monitoring vital body signs of a person seated in a seat of a motor vehicle. The disclosed method unobtrusively monitors vital body signs like heart rate and respiration rate of the person seated in the motor vehicle US 2006/0100530 A1 discloses a system according the preamble of claim 1.

SUMMARY OF THE INVENTION

[0006] There exists a need for a device for and a method of measuring the breathing rate of a patient for overcoming or mitigating one or more of the problems in the state of the art. The need is addressed with a device for measuring the breathing rate of a subject defined in claim 1.

[0007] Such a device may have the advantage that it may not need a skilled person to measure the breathing rate manually. Further, it may not need a skilled person to position a sensor proximate to the patient. Since the device measures the breathing rate, the data may be stored, or transmitted to a system for further processing or used along with the other measured parameters for making decisions or for issuing alarms.

[0008] Further, the need for such a method of measuring the breathing rate of a subject is addressed by a method as defined in claim 14.

[0009] Normally, patient monitors used in ICUs use a sphygmomanometer cuff to measure the subject's BP, among other things. Thus the disclosed method may offer the advantage that it makes it convenient to dispose the transducer in the cuff and once the cuff is worn by the subject, the measurement of the breathing rate of the subject is enabled without any additional positioning of a separate transducer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] These and other aspects of the disclosed device and the disclosed method are described in detail with reference to the following figures, wherein:

Fig. 1 is a schematic diagram of the disclosed device;
Fig. 2 is a diagrammatic representation of the disclosed method; and
Fig. 3 is a representation of the disclosed device in use.

DETAILED DESCRIPTION OF EMBODIMENTS

[0011] Fig. 1 is a schematic diagram of the disclosed device 100. A transducer 107 radiates energy towards the chest of a subject. The transducer 107 also receives the energy reflected by the chest of the subject. Since the chest of the subject is moving due to the subject's breathing the frequency of the reflected energy undergoes Doppler shift. The analyzer 105 receives a signal 106 (to be called transducer signal here after) corresponding to the reflected energy received by the transducer 107. The analyzer 105 analyzes the transducer signal 106 and determines the breathing rate of the subject.

[0012] To give a better picture of the device and its process, an oscillator 103 produces energy at a predetermined frequency and drives the transducer 107. The transducer is preferably an antenna that converts high frequency energy into corresponding electromagnetic radiation and *vice versa* or an ultrasound transducer that converts electrical energy into ultrasound energy of a predetermined frequency and *vice versa*. In the description hereafter only one of them, viz, electromagnetic waves, will be referred to for ease of description. It is to be understood that *mutatis mutandis*, the description applies to ultrasound waves also. However, if there are exceptions, the differences with reference to the two forms of energy will be stated at appropriate places.

[0013] With a stationary transducer, if the energy is reflected by a stationary object, there is no information in it to be demodulated. However in the present case the

reflecting surface is the surface of the chest of the subject that moves in synchronism with the breathing of the subject, at least a part of the movement will be in a direction parallel to the direction of radiation. Thus the frequency of the reflected energy experiences Doppler shifts. The analyzer 105 may demodulate the transducer signal 106. The transducer signal 106 or demodulated signal 106a exhibits a complex dependency on the motion velocity, the motion amplitude and the distance between the chest and sensor. By using appropriate state-of-the-art signal processing, the subject's breathing rate can be obtained from the transducer signal 106 or demodulated signal 106a.

[0014] The analyzer 105 analyzes the signal to determine a pattern corresponding to a complete breathing cycle, in the demodulated signal 106a. It identifies at least the beginning and end of each complete cycle comprising one inhalation and one exhalation.

[0015] The analyzer 105 determines the time period for each cycle or a time period and amplitude of a pattern within each cycle or counts the number of complete cycles in a given period of time. The pattern within the cycle may correspond to the inhalation phase, exhalation phase and pauses, if any, between them. As is well known, to measure low frequencies the method of calculating the time period of each cycle is more accurate. The reciprocal of the period when multiplied by sixty yields the breathing rate of the subject in number of breaths per minute which is the most common unit for breathing rate. The breathing rate and other values determined by the analyzer 105 are outputted appropriately 108.

[0016] In one embodiment, analyzer 105 calculates the breathing rate by Fourier analysis of the transducer signal 106 or the demodulated transducer signal 106a. This may be advantageous for accurate measurements as the effect of noise could be eliminated or suppressed, eliminating the need for determining the start or end points of a cycle and thereby reducing or even eliminating the ambiguity therein.

[0017] In one embodiment, the device may output the demodulated signal 106a in a manner suitable for being displayed on a monitor 109. In another preferred embodiment, limiting values for the various measured values, such as breathing rate, or time for one breath (a complete cycle), time for each inhalation and each exhalation and so on may be input to the device through a suitable user interface 111 and whenever the individual values cross the limiting values, an indication or alarm 110 may be issued by the device. It is to be understood that the indication may be an audio or visual or audio-visual alarm. In one embodiment, the one or more outputs such as the breathing rate, the duration and amplitude of the phases of breathing, etc., may be outputted in a wired or wireless manner, to a central monitoring unit or a bedside unit or a central repository for storing a record of the monitored values or incidents when an alarm was issued.

[0018] Since breathing is a natural biological phenomenon, there may be large variations in the time per cycle between cycles. Thus, if the breathing rate calculated as described above is displayed as is, the display on the monitor 109 may change fairly rapidly and hence may be confusing or difficult to read. Thus, the output 108 may be a running average of a predetermined number of breathing cycles for the display unit to display. Alternatively, both the cycle by cycle breathing rate and the running average may be displayed. Once in a while, subjects take a longer breath than normal voluntarily or involuntarily. In one embodiment, when such events occur, such very long cycles may be dropped from the calculation of the average.

[0019] In one embodiment, the transducer 107 is disposed on a sphygmomanometer cuff 101 as shown in Fig. 1. The transducer may be releasably coupleable to the cuff, for example using hook-and-loop fasteners. Even though the cuff is shown at a distance from the upper arm of the diagrammatic representation of the subject, it is to be understood that the cuff 101 is wrapped or suitably placed on the upper arm of the subject, as prescribed. The transducer 107 is disposed on the cuff so that in use, when the cuff is worn by the subject as prescribed, the direction of radiation of the energy is substantially towards the chest of the subject. When the radiated energy encounters the chest of the subject, at least part of the energy is reflected by the chest and at least a part of the reflected energy is sensed by the transducer 107.

[0020] Fig. 3 shows the cuff 101, the transducer 107 disposed on the cuff 101 worn by a subject, as prescribed. In this embodiment, the breathing rate measurement device and a sphygmomanometer cuff based blood pressure measurement device may be two independent instruments. In one embodiment, the device according to claim 1 and the blood pressure measurement device are housed in the same enclosure. It may have a display that displays both the blood pressure and the breathing rate. In such a case, the antenna maybe advantageously disposed in the cuff, to be worn by the subject to be monitored so that no special care is needed in positioning the transducer in relation to the chest of the subject.

[0021] Now the disclosed method 200 is described in detail with reference to Fig. 2. The method comprises the steps as follows. In a disposing step 213, a transducer is disposed on the arm of the subject. In an analyzing step 215 the signal received from the transducer is analyzed to determine the breathing rate of the subject.

[0022] Since, when the subject breathes, the chest expands and contracts in synchronism with the breathing, the chest moves away from the transducer or towards it during exhalation and inhalation respectively. The movement produces shifts in the frequency of the radiated energy. The frequency shift, the Doppler shift, is negative - frequency lower than the radiated frequency - during exhalation and the shift is positive during inhalation. The magnitude of the shift is proportional to the rate of movement of the chest in relation to the transducer.

[0023] In an analyzing step 215, at least one temporal pattern in the signal is determined. This could mean that the part of the signal that represents the inhalation phase or exhalation phase and the pauses, if any, between them may be determined. At least complete cycles of breathing maybe determined. This means that the start and end points of a complete breathing cycle may be determined. This could also mean that the starting points of two consecutive breathing cycles may be determined.

[0024] Alternatively the breathing rate could also be calculated by Fourier Analysis of the received signal. This may be advantageous for accurate measurements as the effect of noise could be eliminated more easily, reducing the ambiguity in determining the start or end of a cycle.

[0025] The time duration of the complete cycle determined is measured. The reciprocal of this measured time, when multiplied by sixty, yields the breathing rate in breaths per minute. Normally, higher frequencies are measured by counting the number of cycles in a certain period of time and the frequency in Hz is calculated. But for slow or long duration phenomenon, it is preferable to measure the time duration of each cycle and calculate the frequency in a suitable unit - Hz or cycles per minute, for instance.

[0026] The values measured or further values calculated based on those measurements are output suitably. The output could be displayed in the form of alphanumeric display, or with lights or audio-visual display and so on and combinations thereof and is not treated as a part of this description of the method.

[0027] The basic equations necessary to carry out the measurement using Doppler are explained below:

The Doppler signal for a single target, which is a good approximation of a subject's chest, is given by Equation 1 below as:

$$x(t) = a(t) \cdot \cos(\Theta(t))$$

where the amplitude a(t) can be assumed to be constant $a(t) = a_0$, since we consider only small distance changes (~ cm) due to breathing and the beating heart, disregarding large subject movements. The phase-term in the equation above can be expressed by Equation 2 below as:

$$D(t) = \frac{4\pi}{\lambda}(\Xi + \sum_{k=1}^{4} \int_0^t v_k(t')dt') \quad ,$$

where λ is the wavelength of the transmitted waves, and Ξ is the sensor-chest distance for t = 0. The sum consists of 4 terms due to the breathing motion (amplitude A of 5 mm - 30 mm at 0.1 Hz - 0.8 Hz), due to the beating heart (typically < 5 mm at 0.5 Hz - 3 Hz), the patient's global motion and - if applicable - movement of the sensor itself.

[0028] For an ideal measurement situation with breathing motion only and a perfect estimation of the phase term, equation (2) reduces to:

$$D(t) = \frac{4\pi}{\lambda}(\Xi + x(t))$$

wherein s(t) is the displacement of the chest beginning from t=0.

[0029] In one variant of the method the breathing rate displayed is the running average of a predetermined number of previous cycles. In one variant both the present breathing rate based on the latest full cycle and the running average as mentioned above are displayed together. In one variant the output includes an alarm when any of the measured or calculated parameters exceed or cross predetermined thresholds.

[0030] In one embodiment of the method, the transducer is disposed in a sphygmomanometer cuff. In one embodiment the transducer may be integrated into the cuff as an integral part. Since the cuff has a predefined position and orientation of application on the arm of the subject, the transducer may be so coupled or integrated into it, such that when the cuff is applied to the subject's arm properly, the transducer is in the appropriate position relative to the subject's chest for the measurement of the breathing rate.

[0031] The method has hitherto been described as a combination of the cuff based sphygmomanometer and the breathing rate. However it is to be understood that the method may be employed or practiced as an adjunct to or within a monitoring device or system which monitors various other parameters of a subject, for instance in an ICU or any other care facility. The parameters normally measured and monitored in that way are, but not limited to, blood pressure, Blood Oxygen Saturation (SpO2), heart rate and body temperature and so on.

[0032] In one embodiment, electromagnetic waves are used. Though other frequencies may be used, it is found that reliable results are obtained with a frequency of at least 1 GHz. Preferably, the frequency is between 20 GHz and 30 GHz and most preferably the frequency has a nominal value of 24 GHz. In another embodiment, ultrasound energy is employed with a frequency of at least 40 kHz. In other words the device and method may use the principle of Doppler RADAR or ultrasound based Doppler Sonar, also called Acoustic Doppler Sonar, using Ultrasound.

[0033] While the embodiments have been described in detail in the drawings and description, such drawings and description are to be considered exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Wherever electrical connections or com-

munication is referred to, it is to be understood that it could be effected in a wired or wireless manner. For instance, instead of displaying measured values of the duration of each phase of the breathing cycle, one or more of them may be displayed as a ratio of the duration of the phase and the duration of the whole breathing cycle and so on. Units described as distinct may in practice be realized in the same physical unit. The units may be built using any one or more devices of various technologies such as microcontrollers, microprocessors, digital signal processors (DSP's), programmable logic devices and so on. The distinction made here is for the ease of understanding and the implementation of the units and the practice of the steps may be varied by skilled persons to advantage.

Claims

1. A device (100) for monitoring respiration of a subject, the device comprising:

a transducer (107) arranged to be worn on an arm of the subject,
an analyzer (105) operatively coupled to the transducer (107), the transducer (107) being arranged for radiating energy under control of the analyzer, the analyzer being arranged for processing a signal received from the transducer, for determining a respiration rate of the subject in dependence on the Doppler frequency shifts in the reflected energy received by the transducer.

characterized by the transducer (107) being arranged for radiating energy towards the chest of the subject and receiving the energy reflected by the chest of the subject.

2. The device (100) of claim 1 wherein the transducer (107) comprises an ultrasound transducer or an antenna.

3. The device (100) of claim 1 further comprising a sphygmomanometer cuff (101) for monitoring a blood pressure of the subject, the cuff (101) being mechanically coupleable to the transducer (107).

4. The device (100) of claim 3 wherein the transducer (107) is integrated into the sphygmomanometer cuff (101).

5. The device of claim 3 or 4 wherein the sphygmomanometer cuff (101) is further electrically coupleable to the analyzer (105), the sphygmomanometer cuff (101) being arranged for monitoring a blood pressure of the subject in response to a further signal received from the analyzer (105).

6. The device (100) of claim 5 wherein the analyzer (105) is further arranged to receive data on the monitored blood pressure from the sphygmomanometer cuff (101).

7. The device (100) according to any one of claims 3 to 6 wherein the analyzer (105) is arranged for wireless communication with the transducer (107) or the cuff (101) or both to allow remote monitoring of the subject.

8. The device (100) of claim 1, wherein the analyzer (105) is further configured for identifying at least one breathing phase from the transducer signal and for calculating at least one of a duration and an amplitude of the identified phase.

9. The device (100) of claim 1, wherein the analyzer (105) is further configured for averaging at least one of the periodicity of respiration, the number of cycles of respiration per unit time, the duration of the phase, and the amplitude of the phase over at least one of a predetermined time period and a predetermined previous number of cycles.

10. The device (100) of claim 9, wherein the analyzer (105) is further configured for using a current value within predetermined upper and lower limiting values or values that are within a predetermined multiple of a current average value, for calculating a subsequent average value.

11. The device (100) of claim 10 wherein the analyzer (105) is configured for comparing at least one of the periodicity, the number of cycles per unit time, the duration of one or more phases and the amplitude of one or more phases with at least one threshold value for each of those values for generating an alarm signal.

12. The device (100) of claim 2, wherein the radiated energy has a frequency of at least 1 GHz, preferably between 20 GHz and 30 GHz and most preferably in the order of 24 GHz.

13. The device (100) of claims 2, wherein the radiated energy is ultrasound energy with a frequency of at least 40 kHz.

14. A method (200) of monitoring the respiratory rate of a subject, the method comprising the steps of:

a disposing step (213) of disposing a transducer on an arm of a subject for radiating energy towards the chest of the subject and receiving the energy reflected by the chest of the subject;
an analyzing step of (215) of analyzing a signal received from the transducer, for determining a

respiration rate of the subject in dependence on the Doppler frequency shifts in the transducer signal.

15. The method (200) of claim 14, wherein the disposing is by mechanically coupling to or integrating the transducer into a sphygmomanometer cuff.

Patentansprüche

1. Vorrichtung (100) zur Überwachung der Atmung einer Person, wobei die Vorrichtung umfasst:

einen Transducer (107), der zum Tragen auf einem Arm der Person eingerichtet ist,
einen mit dem Transducer (107) betriebsbereit verbundenen Analysator (105), wobei der Transducer (107) so eingerichtet ist, dass er unter Steuerung des Analysators Energie abstrahlt, wobei der Analysator so eingerichtet ist, dass er ein von dem Transducer empfangenes Signal verarbeitet, um eine Atmungsrate der Person in Abhängigkeit der Doppler-Frequenzverschiebungen in der von dem Transducer empfangenen reflektierten Energie zu ermitteln,

dadurch gekennzeichnet, dass der Transducer (107) so eingerichtet ist, dass er Energie zu dem Brustkorb der Person hin abstrahlt und die von dem Brustkorb der Person reflektierte Energie empfängt.

2. Vorrichtung (100) nach Anspruch 1, wobei der Transducer (107) einen Ultraschall-Transducer oder eine Antenne umfasst.

3. Vorrichtung (100) nach Anspruch 1, die weiterhin eine Blutdruckmessgerätmanschette (101) zur Überwachung eines Blutdrucks der Person umfasst, wobei die Manschette (101) mit dem Transducer (107) mechanisch verbindbar ist.

4. Vorrichtung (100) nach Anspruch 3, wobei der Transducer (107) in die Blutdruckmessgerätmanschette (101) integriert ist.

5. Vorrichtung (100) nach Anspruch 3 oder 4, wobei die Blutdruckmessgerätmanschette (101) weiterhin mit dem Analysator (105) elektrisch verbindbar ist, wobei die Blutdruckmessgerätmanschette (101) so eingerichtet ist, dass sie einen Blutdruck der Person in Reaktion auf ein von dem Analysator (105) empfangenes weiteres Signal überwacht.

6. Vorrichtung (100) nach Anspruch 5, wobei der Analysator (105) weiterhin so eingerichtet ist, dass er von der Blutdruckmessgerätmanschette (101) Daten über den überwachten Blutdruck empfängt.

7. Vorrichtung (100) nach einem der Ansprüche 3 bis 6, wobei der Analysator (105) zur drahtlosen Kommunikation mit dem Transducer (107) oder der Manschette (101) oder beiden eingerichtet ist, um eine Fernüberwachung der Person zu ermöglichen.

8. Vorrichtung (100) nach Anspruch 1, wobei der Analysator (105) weiterhin so eingerichtet ist, dass er aus dem Transducer-Signal mindestens eine Atmungsphase identifiziert und zumindest eine Dauer oder eine Amplitude der identifizierten Phase berechnet.

9. Vorrichtung (100) nach Anspruch 1, wobei der Analysator (105) weiterhin so eingerichtet ist, dass er mindestens eine der folgenden mittelt: die Atmungsperiodizität, die Anzahl von Atmungszyklen pro Zeiteinheit, die Dauer der Phase sowie die Amplitude der Phase über zumindest einen vorher festgelegten Zeitraum oder eine vorher festgelegte Anzahl von Zyklen.

10. Vorrichtung (100) nach Anspruch 9, wobei der Analysator (105) weiterhin so eingerichtet ist, dass er einen aktuellen Wert innerhalb eines vorher festgelegten oberen und unteren Grenzwertes oder Werte, die innerhalb eines vorher festgelegten Mehrfachen eines aktuellen Durchschnittswertes liegen, verwendet, um einen nachfolgenden Durchschnittswert zu berechnen.

11. Vorrichtung (100) nach Anspruch 10, wobei der Analysator (105) so eingerichtet ist, dass er zumindest die Atmungsperiodizität, die Anzahl von Zyklen pro Zeiteinheit, die Dauer einer oder mehrerer Phasen sowie die Amplitude einer oder mehrerer Phasen mit mindestens einem Schwellenwert für jeden solcher Werte zur Erzeugung eines Alarmsignals vergleicht.

12. Vorrichtung (100) nach Anspruch 2, wobei die abgestrahlte Energie eine Frequenz von mindestens 1 GHz, vorzugsweise zwischen 20 GHz und 30 GHz, am besten in der Größenordnung von 24 GHz, aufweist.

13. Vorrichtung (100) nach Anspruch 2, wobei es sich bei der abgestrahlten Energie um Ultraschallenergie mit einer Frequenz von mindestens 40 kHz handelt.

14. Verfahren (200) zur Überwachung der Atmungsrate einer Person, wobei das Verfahren die folgenden Schritte umfasst:

einen Anordnungsschritt (213), um einen Transducer so auf einem Arm einer Person anzuordnen, dass er Energie zu dem Brustkorb der Person hin abstrahlt und die von dem Brustkorb der Person reflektierte Energie empfängt;

einen Analysierungsschritt (215) zum Analysieren eines von dem Transducer empfangenen Signals, um eine Atmungsrate der Person in Abhängigkeit der Doppler-Frequenzverschiebungen in dem Transducer-Signal zu ermitteln.

15. Verfahren (200) nach Anspruch 14, wobei das Anordnen durch mechanisches Verbinden mit einer Blutdruckmessgerätmanschette oder durch Integrieren des Transducers in diese erfolgt.

Revendications

1. Dispositif (100) de surveillance de la respiration d'un sujet, le dispositif comprenant :

un transducteur (107) conçu pour être porté sur un bras du sujet,
un analyseur (105) couplé opérationnellement au transducteur (107), le transducteur (107) étant conçu pour rayonner de l'énergie sous commande de l'analyseur, l'analyseur étant conçu pour traiter un signal reçu en provenance du transducteur, pour déterminer une fréquence respiratoire du sujet en fonction des décalages de fréquence doppler de l'énergie réfléchie reçue par le transducteur,

caractérisé en ce que le transducteur (107) est conçu pour rayonner de l'énergie vers la cage thoracique du sujet et recevoir l'énergie réfléchie par la cage thoracique du sujet.

2. Dispositif (100) selon la revendication 1, dans lequel le transducteur (107) comprend un transducteur ultrasonore ou une antenne.

3. Dispositif (100) selon la revendication 1, comprenant en outre une manchette de sphygmomanomètre (101) pour surveiller une pression artérielle du sujet, la manchette (101) pouvant être couplée mécaniquement au transducteur (107).

4. Dispositif (100) selon la revendication 3, dans lequel le transducteur (107) est intégré dans la manchette de sphygmomanomètre (101).

5. Dispositif (100) selon la revendication 3 ou 4, dans lequel la manchette pour sphygmomanomètre (101) peut en outre être couplée électriquement à l'analyseur (105), la manchette de sphygmomanomètre (101) étant conçue pour surveiller une pression artérielle du sujet en réponse à un signal supplémentaire reçu en provenance de l'analyseur (105).

6. Dispositif (100) selon la revendication 5, dans lequel l'analyseur (105) est en outre conçu pour recevoir des données sur la pression artérielle surveillée en provenance de la manchette de sphygmomanomètre (101).

7. Dispositif (100) selon l'une quelconque des revendications 3 à 6, dans lequel l'analyseur (105) est conçu pour une communication sans fil avec le transducteur (107) ou la manchette (101) ou les deux afin de permettre une télésurveillance du sujet.

8. Dispositif (100) selon la revendication 1, dans lequel l'analyseur (105) est en outre configuré pour identifier au moins une phase de respiration du signal de transducteur et pour calculer au moins l'une d'une durée et d'une amplitude de la phase identifiée.

9. Dispositif (100) selon la revendication 1, dans lequel l'analyseur (105) est en outre configuré pour établir la moyenne d'au moins l'un de la périodicité de respiration, du nombre de cycles de respiration par unité de temps, de la durée de la phase, et de l'amplitude de la phase sur au moins l'un d'une période prédéterminée et d'un nombre précédent prédéterminé de cycles.

10. Dispositif (100) selon la revendication 9, dans lequel l'analyseur (105) est en outre configuré pour utiliser une valeur actuelle dans des valeurs de limitation supérieure et inférieure prédéterminées ou des valeurs qui sont dans un multiple prédéterminé d'une valeur moyenne actuelle, afin de calculer une valeur moyenne ultérieure.

11. Dispositif (100) selon la revendication 10, dans lequel l'analyseur (105) est configuré pour comparer au moins l'un de la périodicité, du nombre de cycles par unité de temps, de la durée d'une ou de plusieurs phases et de l'amplitude d'une ou de plusieurs phases à au moins une valeur seuil pour chacune de ces valeurs afin de générer un signal d'alarme.

12. Dispositif (100) selon la revendication 2, dans lequel l'énergie rayonnée a une fréquence d'au moins 1 GHz, de préférence entre 20 GHz et 30 GHz et de manière préférée entre toutes de l'ordre de 24 GHz.

13. Dispositif (100) selon la revendication 2, dans lequel l'énergie rayonnée est une énergie ultrasonore avec une fréquence d'au moins 40 kHz.

14. Procédé (200) de surveillance de la fréquence respiratoire d'un sujet, le procédé comprenant les étapes suivantes :

une étape de disposition (213) consistant à disposer un transducteur sur un bras d'un sujet pour rayonner de l'énergie vers la cage thoracique du sujet et recevoir l'énergie réfléchie par

la cage thoracique du sujet ;
une étape d'analyse (215) consistant à analyser un signal reçu en provenance du transducteur, pour déterminer une fréquence respiratoire du sujet selon les décalages de fréquence Doppler dans le signal de transducteur.

15. Procédé (200) selon la revendication 14, dans lequel la disposition se fait par couplage mécanique à ou par intégration du transducteur dans une manchette de sphygmo mano mètre.

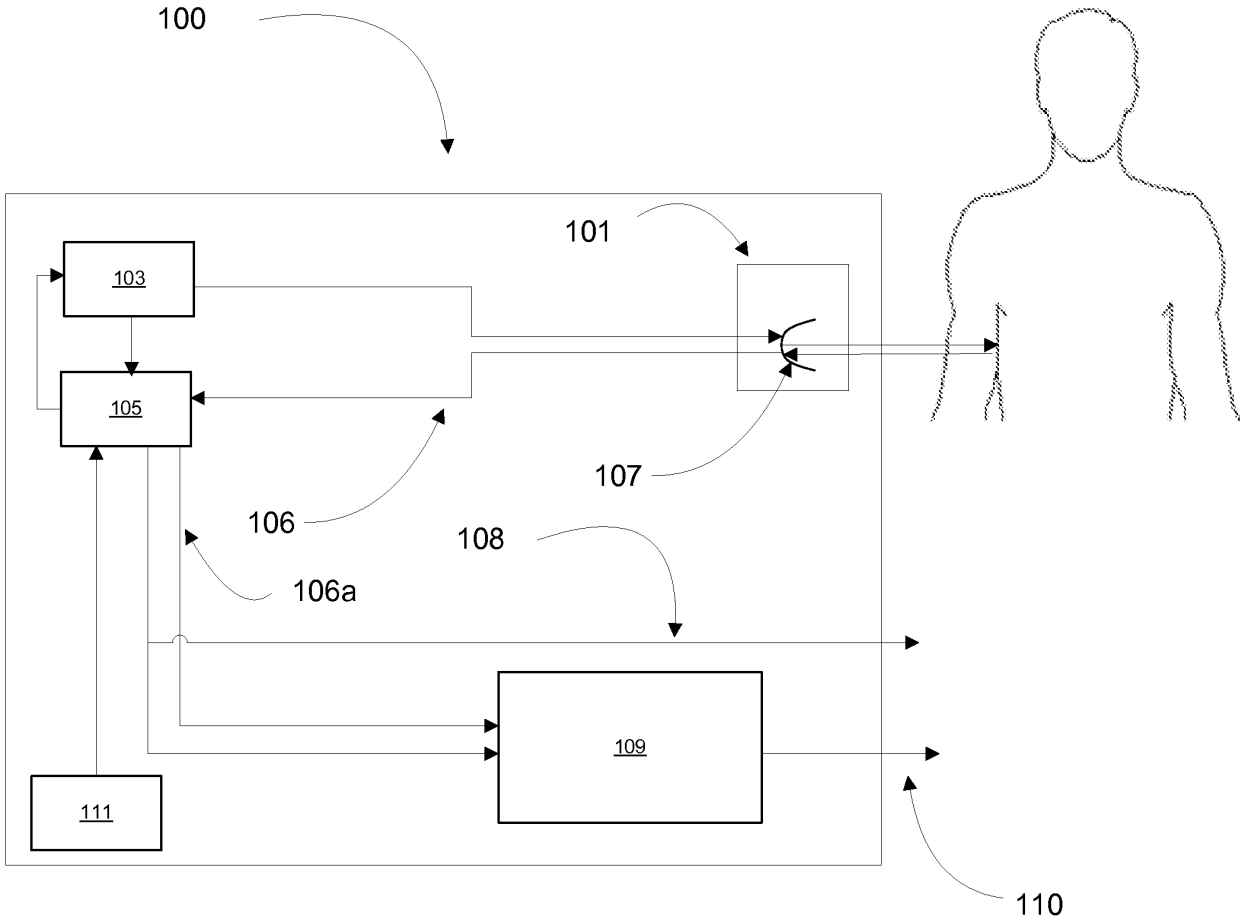

Fig. 1

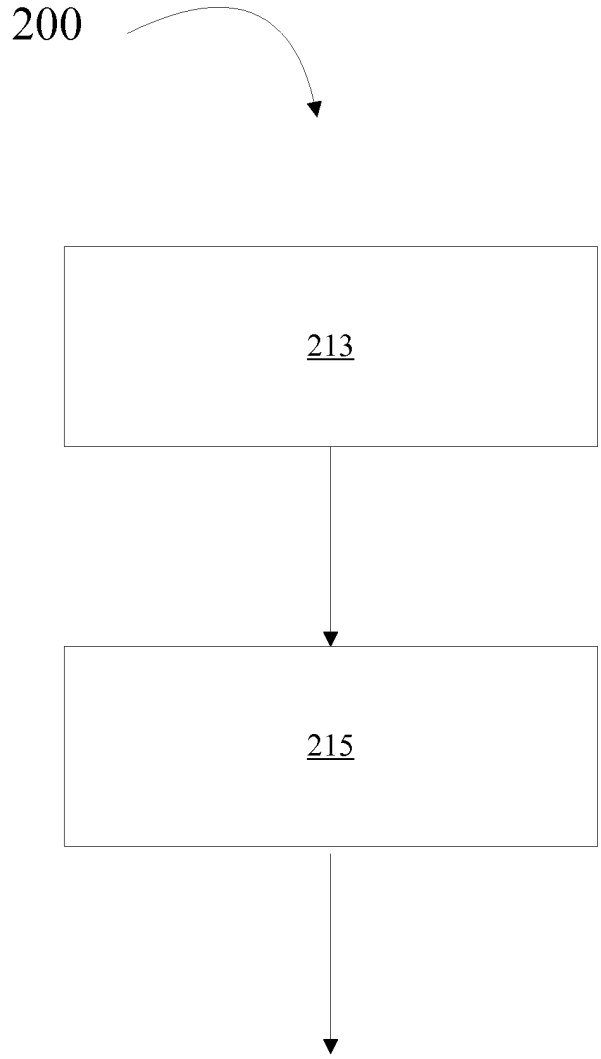

Fig. 2

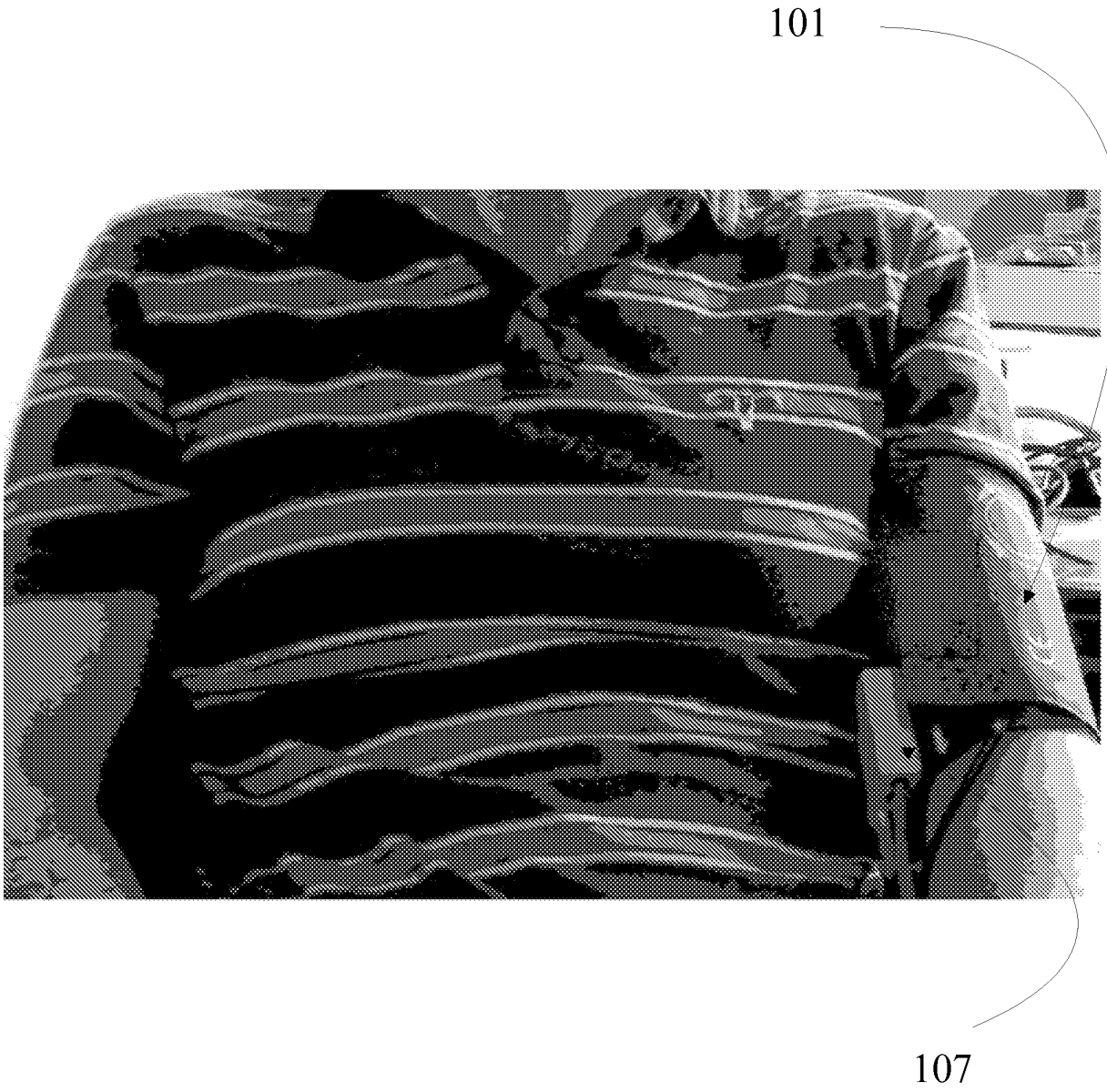

Fig. 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20100222687 A **[0005]**
- US 20060100530 A1 **[0005]**

patsnap

专利名称(译)	用于呼吸速率测量的系统和方法		
公开(公告)号	EP2906104B1	公开(公告)日	2016-06-08
申请号	EP2013785655	申请日	2013-10-03
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	MUHLSTEFF JENS		
发明人	MÜHLSTEFF, JENS		
IPC分类号	A61B5/00 A61B5/08 A61B5/022		
CPC分类号	A61B5/0205 A61B5/022 A61B5/0816 A61B5/6824 A61B5/7278 A61B8/08		
代理机构(译)	合作社，PETER		
优先权	61/711290 2012-10-09 US		
其他公开文献	EP2906104A1		
外部链接	Espacenet		

摘要(译)

公开了一种用于监测受试者呼吸速率的装置（100）。换能器（107）向对象的胸部辐射能量并接收反射的能量。分析器（105）接收与反射能量相对应的信号。参考换能器，由于呼吸引起的受试者胸部的运动，反射的能量将经历多普勒频率偏移。分析器（105）通过测量信号的周期性和信号的每单位时间的周期数中的至少一个来分析信号以计算呼吸率。在优选实施例中，换能器（107）设置在血压计袖带中或血压计袖带上，以朝向受试者的胸部辐射能量，并接收由受试者的胸部反射的能量。

$$x(t)=a(t)\cdot\cos(\Theta(t))$$