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(54) Title: SYSTEM FOR RECORDING CHEST SIGNALS AND METHOD USING SAID SYSTEM

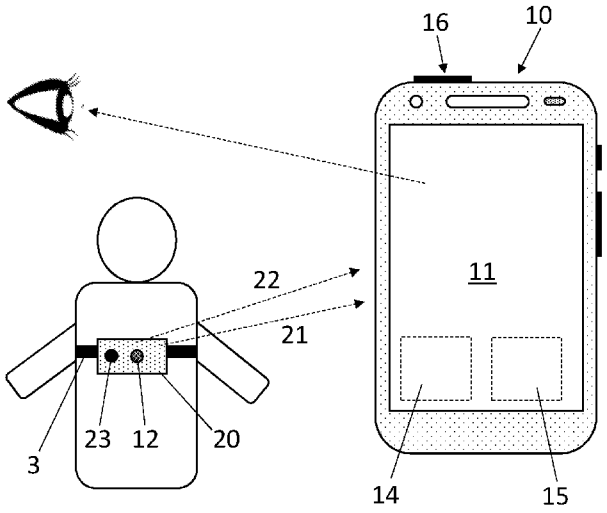

Fig. 1

(57) Abstract: The present invention concerns a system (100) for recording chest signals of a user, the system comprising: a sensing unit (20) comprising a first sensor (12) configured for recording a chest signal (21) from the chest of the user; a remote control device (10) connectable with the sensing unit (20) and configured for generating guiding information comprising a recording procedure to follow when performing the recording; means for processing the chest signal (21) such as to determine a confidence criterion of the chest acoustic signal (21); the remote control device (10) being further configured for generating instructional information comprising information about the determined confidence criterion, and comprising an interface (11) allowing the user, or an assistant performing the recording on the user, to initiate and/or stop the recording or initiate a further analysis of the processed chest signal (21). The present invention also concerns a method for recording the chest signals of a user using the system.

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[Continued on next page]

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System for recording chest signals and method using said system

Field

[0001] The present invention concerns a system for recording chest signals of a user with improved reliability. The present invention further concerns a method for obtaining chest signals of a user using the system.

Description of related art

[0002] Chest signals are typically recorded by a physician using a stethoscope. The physician checks the quality of the recorded chest signals by analyzing what he is hearing. When performing the recording, the physician may try to record a good signal by stabilizing the head of the stethoscope on the chest of his patient. He may also ask his patient to perform certain tasks, such as breathing with the mouth open, coughing, etc. He also insures that the stethoscope is positioned at the correct location on the chest.

[0003] A patient willing to record himself his chest sounds, has typically no idea whether the recorded sounds he gets are reliable and can be used for further analysis. During the recording process, the patient's hand holding the stethoscope might move, the patient's chest might also move. The patient may further perform inappropriate respiratory tasks. Therefore, the recorded chest sounds may be unreliable and thus useless for further analysis.

[0004] Document WO11073879 describes a signal processing apparatus and its method of operation. The apparatus comprises a phonocardiogram interface adapted to receive a phonocardiogram signal, a processor adapted to analyze the phonocardiogram signal, and a flow control adapted to determine, whether a subsequent capture of the phonocardiogram signal according to a second set of capturing properties is likely to improve an accuracy of the determined analysis result. The apparatus measures only sounds related to heart. The apparatus is only

able to collect good phonocardiogram signals when the user does not breath or move during the recording period.

Summary

[0005] The present invention concerns a system for recording chest signals of a user, the system comprising: a sensing unit comprising a first sensor configured for recording a chest signal from the chest of the user; a remote control device connectable with the sensing unit and configured for generating guiding information comprising a recording procedure to follow when performing the recording; means for processing the chest signal such as to determine a confidence criterion of the chest signal; the remote control device being further configured for generating instructional information comprising information about the determined confidence criterion, and comprising an interface allowing the user, or an assistant performing the recording on the user, to initiate and/or stop the recording or initiate a further analysis of the processed chest signal. .

[0006] The present invention concerns a method for recording chest signals of a user using the system, the method comprising:

connecting the sensing unit with the remote control device;

recording a chest signal;

using the remote control device for generating guiding information comprising a recording procedure to follow when performing the recording ;

processing the measured chest signal such as to determine a confidence criterion of the chest signal; and

using the remote control device for generating instructional information comprising information about the determined confidence criterion to initiate and/or stop the recording or initiate a further analysis of the processed chest signal.

[0007] The system and method disclosed herein allows for recording lung-related chest signals. When recording lung-related signals, breathing

patterns and user's movements are of importance in reducing noise artifacts in the recorded chest signal and obtaining a reliable chest signal. The present system and method is able to guide the user in his breathing pattern and the guidance can be personalized as a function to each user using the system and method.

[0008] The recorded chest signals have a good accuracy and reliability.

Brief Description of the Drawings

[0009] The invention will be better understood with the aid of the description of an embodiment given by way of example and illustrated by the figures, in which:

Fig. 1 shows a system for obtaining chest signals of a user, according to an embodiment; and

Fig. 2 schematically represents a method for obtaining chest signals of a user using the system, according to an embodiment.

Detailed Description of possible embodiments

[0010] Fig. 1 shows a system 100 for obtaining chest signals of a user, according to an embodiment. The system 100 comprises a sensing unit 20 comprising a first sensor 12 configured for recording a chest signal 21. A remote control device 10 is connectable with the sensing unit 20 and configured for generating guiding information comprising a recording procedure to follow when performing the recording configured to receive the chest signal 21.

[0011] The system 100 further comprises means for processing the chest signal 21 such as to determine a confidence criterion of the chest signal 21. The remote control device 10 is further configured for generating instructional information comprising information about the determined confidence criterion. The remote control device 10 comprises an interface 11 allowing the user, or an assistant performing the recording on the user,

to initiate and/or stop the recording or initiate a further analysis of the processed chest signal 21.

[0012] The first sensor 12 can be configured for recording a vibration form the user's chest (thorax) such that the chest signal 21 is a vibration signal. The first sensor 12 can be configured for measuring vibrations as sound waves with frequencies between about 20 Hz and 20 kHz. The sensing unit 20 can be configured for measuring vibrations with frequencies above 20 kHz (ultrasounds) and/or below 20 Hz (infrasound). The first sensor 12 can comprise a sound transducer such as a microphone or any suitable arrangement for registering chest sounds waves and providing a corresponding acoustic signal. In a particular embodiment, the first sensor 12 can comprise a stethoscope or an electronic stethoscope.

[0013] Alternatively, the first sensor 12 can comprise a contact microphone that senses audio vibrations through contact with the user's chest. Example of contact microphone include a microphones based on piezo materials or an accelerometer. The first sensor 12 can be a multi-sensor. The first sensor 12 can further comprise a motion sensor.

[0014] In the particular embodiment of Fig. 1, the sensing unit 20 is comprised on a belt, or strap, 3 that is destined to be worn on the user's chest such that the sensing unit 20 located in a region of the user's chest (torso). The sensing unit 20 can also be maintained in a region of the user's chest by using a self-adhesive pad that holds the sensing unit 20 or an adhesive. The first sensor 12 comprising a contact microphone or a sound transducer can be arranged in close contact with the user's skin, possibly direct contact with the skin. The first sensor 12 can also be in contact with the user's chest through a tissue material (for example the sensing unit 20 can be placed on a t-shirt) or any other suitable materials. Such suitable materials can comprise a gel or rubber, such as a rubber ring in a stethoscope.

[0015] Positioning the sensing unit 20 on the chest with the strap 3 allows for reducing friction noise between the first sensor 12 and the chest.

The strap avoid hand holding the sensing unit 20. Physiological user's hand movements can add noise to the sound recorded by the first sensor 12, thus using the strap 3 allows this type of noise to be reduced. Positioning the sensing unit 20 on the chest with the strap 3 further allows for recording chest sounds (chest signals 21) from the back of the chest. An external person is then not required for holding the sensing unit 20 in this position.

[0016] The sensing unit 20 on the chest with the strap 3 can be used on bare skin, a hairy skin and on a lightly clothed skin (i.e., t-shirt).

[0017] In an embodiment, the sensing unit 20 is configured for measuring a complementary signal 22 from the user. To that end, the sensing unit 20 can comprise a complementary sensor 23.

[0018] In particular, the complementary sensor 23 can comprise a motion sensor configured for measuring a motion signal, such that the complementary signal 22 comprises a motion signal. The motion sensor can comprise an accelerometer, a gyroscope, a magnetometer or any suitable sensor for measuring a body motion of the user. The complementary sensor 23 can comprise a piezoelectric sensor configured for performing ballistocardiography measurements, yielding user's body vibrations due to its cardiac and respiratory physiological signatures. Alternatively, the complementary sensor 23 can be configured for performing apex cardiography recording of low-frequency pulsations at the anterior chest wall over the apex of the heart.

[0019] The complementary sensor 23 can comprise a physiological electrical signal measuring sensor configured for measuring electrical signals, such that the complementary signal 22 comprises electrical signals. Examples of electrical signal measuring sensor comprises an electrocardiograph (ECG) device, an impedance cardiograph (ICG) device or an electromyograph (EMG) device.

[0020] The complementary sensor 23 can comprise an optical sensor configured for measuring physiological optical signals such that the

complementary signal 22 comprises optical signals. In particular, the sensing unit 20 can comprise a PPG sensor or a camera for measuring visual signal.

[0021] The complementary sensor 23 can comprise a sensor configured for measuring a body temperature, for example using an infrared camera. The complementary sensor 23 can further configured for performing a respiratory measurement, for example using an airflow sensor.

[0022] The complementary sensor 23 can comprise a medical imaging device, for example including one of: ultrasonography, x-ray medical imaging, computed tomography (CT) scan, magnetic resonance imaging (MRI), positron-emission tomography (PET) scan.

[0023] The complementary sensor 23 can comprise a blood pressure sensor configured for measuring a physiological blood pressure signal, such that the complementary signal 22 comprises a blood pressure signal. Examples of blood pressure sensors include a blood pressure strap, an invasive catheter or a cuffless blood pressure monitoring device described in: "Cuffless blood pressure monitoring: CSEM's portfolio of non-occlusive technologies", Research, May 2016 (https://www.researchgate.net/publication/303487231_Cuffless_blood_pressure_monitoring_CSEM%27s_portfolio_of_non-occlusive_technologies).

[0024] The complementary sensor 23 can comprise any one of the sensors described above alone or in combination. The complementary sensor 23 can be a multi-sensor.

[0025] The complementary sensor 23 can be located in the vicinity to the first sensor 12 such that, when the sensing unit 20 contact the user, the sensing unit 20 and the complementary sensor 23 are measuring in the same area of the in the user's body. In the example of Fig. 1, both the first sensor 12 and the complementary sensor 23 are mounted close to each other on the strap 3.

[0026] However, the complementary sensor 23 need not to be in the vicinity to the first sensor 12 and can be destined to be placed on another area of the user's body. For example, in the case of an ECG and/or ICG sensor, the ECG and/or ICG electrodes can be placed at different body location that that of the first sensor 12. A PPG sensor can be placed on an extremity of the user's body, such as the fingers or earlobes.

[0027] In an embodiment, the remote control device 10 is configured for using the complementary signal 22 in combination with the chest signal 21 for determining the confidence criterion.

[0028] The complementary sensor 23 can be configured to record the complementary signal 22 independently in time with the recording of the chest signal 21. Alternatively, the complementary sensor 23 can be configured to record the complementary signal 22 substantially simultaneously with the recording of the chest signal 21. In the latter configuration, the coincidence in time between the recorded chest signal 21 and complementary signal 22 can be taken into account in determining the confidence criterion.

[0029] In the embodiment shown in Fig. 1, the sensing unit 20 is remote from the control device 10. The sensing unit 20 is then configured for transmitting the chest signal 21 and, when the system 100 comprises the complementary sensor 23, the complementary signal 21 to the control device 10. Here, the sensing unit 20 can comprise a stethoscope and the control device 10 can comprise a smartphone.

[0030] The sensing unit 20 may include a communications interface for communicating with the control device 10 via any communications means, including Wi-Fi protocol, Bluetooth protocol, 4G LTE protocol, etc. Alternatively, the sensing unit 20 may communicate with the control device 10 via a cable.

[0031] Alternatively, the sensing unit 20 and the control device 10 can be comprised in a single device to be worn by the user. Here, the system 100 can comprise an electronic stethoscope.

[0032] According to an embodiment schematically represented in Fig. 2, a method for obtaining chest signals of a user using the system 100 can comprise the steps of:

connecting the sensing unit 20 with the remote control device 10;

recording a chest signal 21;

using the remote control device 10 for generating guiding information comprising a recording procedure to follow when performing the recording;

processing the measured chest signal 21 such as to determine a confidence criterion of the chest signal 21; and

using the remote control device 10 for generating instructional information comprising information about the determined confidence criterion to initiate and/or stop the recording or initiate a further analysis of the processed chest signal 21.

[0033] Recording a chest signal 21 can be performed by the user from which the chest signal 21 is recorded. Alternatively, another person (an assistant) can use the system 100 to obtain chest signals 21 of a user.

[0034] Generating guiding information is typically performed prior or/and during the step of recording the chest signal 21.

[0035] In an embodiment, guiding information includes breathing guidance information destined to the user, including any one of: how to inspire, how to expire, stop breathing, alone or in combination. Breathing guidance information can further include instructions such as: move chest without breathing, cough, etc. Breathing guidance information can further comprise instructions on movements the user should perform or whether the user should rest, during the recording.

[0036] In an embodiment, the method includes a step of generating initial information comprising a predetermined location where the user, or an assistant, should place the first sensor 12 on the user's chest. For example, predetermined locations can include different locations on the front chest and different locations on the back chest. The step of generating initial information can be performed before the step of recording the chest signal 21.

[0037] Generating instructional information is performed after the step of recording the chest signal 21, based on the processing step. Instructional information can comprise information about the determined confidence criterion.

[0038] Processing the measured chest signal 21 can comprise a step of pre-processing the recorded chest signal 21, such as normalization, filtering, formatting, etc. Processing the measured chest signal 21 can further comprise a step of extracting features from the recorded chest signal 21. In the case features are extracted from the chest signal 21, determining a confidence criterion can comprise using the extracted feature to predict a confidence criterion.

[0039] Processing the measured chest signal 21 can be performed simultaneously with the recording time period or during a different time period. Processing the recorded chest signal 21 can be performed in the control device 10 or in a remote location (remote server).

[0040] In an embodiment, processing the measured chest signal 21 comprise using the complementary signal 22 in combination with the chest signal 21 for determining the confidence criterion.

[0041] For example, the complementary signal 22 measured from an ECG and/or an ICG sensor adds heart and respiratory information to the chest signal 21.

[0042] The complementary signal 22 measured from a motion sensor (accelerometer, gyroscope or magnetometer) adds a heart and respiratory motion information to the chest signal 21.

[0043] The complementary signal 22 measured from a PPG sensor and/or a camera focused on the chest adds respiratory and heart information to the chest signal 21.

[0044] The complementary signal 22 information can thus be used when processing the measured chest signal 21 to help identifying heart and respiratory sounds comprised in the chest signal 21 and separate this contribution from noise. The complementary signal 22 information used can comprise one of the motion signal, electrical signal, optical signal or blood pressure signal alone or in combination.

[0045] The determined confidence criterion allows for classifying the processed chest signal 21 as reliable, i.e. the processed chest signal 21 can be used for diagnostic purpose, or unreliable, i.e. the processed chest signal 21 cannot be used for diagnostic purpose and another recording of a chest signal 21 need be performed.

[0046] In an embodiment, the system 100 comprises a display unit 11. The display unit 11 can be used for displaying instructional information. The display unit 11 can be used for displaying the guiding information and/or the initial information.

[0047] Alternatively or in combination, the system 100 can comprise a speaker device 16 (loudspeaker, earphones, ...) for signaling the instructional information, the guiding information and/or the initial information to the user or assistant.

[0048] The display unit 11 and/or speaker device 16 can be comprised in the remote control device 10. In case the remote control device 10 is a smartphone, the display unit 11 can be the phone display and the speaker device 16 can comprise headphones connected to the smartphone. The

step of recording the chest signal 21 can be initiated and/or stopped by interacting with an interface 17 of the remote control device 10 (for example through the display interface 17 of the smartphone). The step of transmitting the process chest signal 21 to an external server can also be initiated by interacting with the remote control device 10.

[0049] The method can further comprise a step of analyzing the processed chest signal 21 that are classified as reliable.

[0050] The analysis can be performed on the processed chest signal 21 being represented as a temporal / amplitude signal or as a temporal / spectral signal (such as a spectrogram or a mel-frequency cepstrum MFC).

[0051] Example of analysis can include: finding noisy parts of the processed chest signal 21 and annotate them as unusable; finding well-recorded parts of the processed chest signal 21 and annotate them with cardiorespiratory labels; use the cardiorespiratory labels to set-up a differential diagnosis procedure. The complementary signal 22 can be used when performing the analysis of the processed chest signal 21.

[0052] The analysis of the processed chest signal 21 can yield analysis data, for example including a quality metric, the cardiorespiratory labels and the differential diagnosis procedure.

[0053] In an embodiment, the step of analyzing is performed by an expert, such as a medical professional. To that end, the processed chest signal 21 can be transmitted to an external server. The external server may be connected to a network, such as the Internet in communication with a remote device that can be accessed by the expert. The expert may perform the analysis through listening and/or visualizing, or by any other appropriate procedure. The expert can analyze the transmitted processed chest signal 21 from a location that is remote from the system 100 and the user and also at a moment that is different from the time where the measurement is performed by the system 100.

[0054] In another embodiment, the step of analyzing is performed by a computer software expert, for example that uses supervised machine-learning classification and regression techniques. The computer analysis can be performed in the system 100, for example in the remote control device 10, or in an external server.

[0055] The step of analyzing can be initiated by the user, or the assistant, by using the interface 17.

[0056] The analyzed chest signal 21 (by the expert or by the computer software expert) and/or the analysis data can be transmitted back to the system 100, if the analysis was performed on an external server.

[0057] The analyzed chest signal 21 and/or the analysis data can be displayed in the display unit 11 and/or signaled in the speaker device 16 16.

[0058] In an embodiment, the system 100 comprises a storage media 14. The storage media 14 can be comprised in the sensing unit 20 (for example in an electronic stethoscope), in the remote control device 10, or in an external server.

[0059] The method can further comprise a step of storing the analyzed chest signal 21 and/or the analysis data in the storage media 14. Interaction labels, i.e., comprising initial information, guiding information and/or instructional information used for performing the recording step, can also be stored in the storage media 14.

[0060] The storage media 14 can further store not-yet analyzed processed chest signal 21 along with the corresponding confidence criterion. In other words, all recorded chest signals 21 are stored after the processing step.

[0061] Any one of the not-yet analyzed processed chest signal 21, corresponding confidence criterion, analyzed chest signal 21, complementary signals 22, interaction labels, well-recorded parts of the

expert-analyzed chest signal 21 or the analysis data can be used, alone or in combination, to build a user-specific database.

[0062] The database can further comprise a generic database comprising a plurality of chest signals previously recorded from the user.

[0063] The user-specific database can be combined with the generic database.

[0064] A supervised database can be built by using the user-specific database, possibly combined with the generic database.

[0065] The database can be used to optimize and personalize the step of processing the measured chest signal 21 and determine the confidence criterion.

[0066] In particular, the supervised database can then be used for providing a classification or regression method. The supervised data-based classification or regression method obtained from the supervised database can be used for determining the confidence criterion.

[0067] The supervised database can be used to optimize and personalize the step of processing the recorded chest signal 21 and determine the confidence criterion. Personalize the step of processing can comprise complementing user-specific data to other users data already available, for example available from a remote server, when building the supervised database and computer software expert model that is fitted to the user.

[0068] For example, the supervised database can be used to optimize a supervised machine-learning classification and regression techniques. It can be further used by the computer software expert when performing supervised machine-learning classification and regression techniques.

[0069] The supervised database classification or regression method hyperparameters can be optimized through cyclic use of the combined user-specific database.

[0070] A supervised algorithm can be applied to maximize the detection of parts in the processed chest signal 21 that cannot be used by the expert analysis. Using the interaction labels, the supervised algorithm can be made to inform the user what respiratory movement he should perform and how he can correct this movement for the next recording step in order to improve the reliability of the recorded chest signal 21.

[0071] In an embodiment, a computer medium comprising portions of code for a software application is configured to be executed in the remote control device 10. When executed, the software application is configured for performing the method.

[0072] The user can use the system 100 according to the displayed measurement information increasing the quality of the chest signal 21 measured with the sensing unit 20.

Reference numeral used in the figures

10	remote control device
11	interface, display unit
12	first sensor
14	storage media
15	computing unit
16	speaker device
20	sensing unit
21	chest signal
22	complementary signal
23	complementary sensor
3	strap
100	system

Claims

1. A system (100) for recording chest signals of a user, the system comprising:

a sensing unit (20) comprising a first sensor (12) configured for recording a chest signal (21) from the chest of the user;

a remote control device (10) connectable with the sensing unit (20) and configured for generating guiding information comprising a recording procedure to follow when performing the recording;

means for processing the chest signal (21) such as to determine a confidence criterion of the chest signal (21);

the remote control device (10) being further configured for generating instructional information comprising information about the determined confidence criterion, and comprising an interface (11) allowing the user, or an assistant performing the recording on the user, to initiate and/or stop the recording or initiate a further analysis of the processed chest signal (21).

2. The system according to claim 1,
wherein the first sensor (12) is configured for recording a vibration from the user's chest such that the chest signal (21) is a vibration signal.

3. The system according to claim 2,
wherein the first sensor (12) comprises a sound transducer.

4. The system according to claim 2,
wherein the first sensor (12) comprises a contact microphone or a motion sensor.

5. The system according to any one of claims 1 to 4,
wherein the sensing unit (20) is further configured for measuring a complementary signal (22) from the user.

6. The system according to claim 5,
wherein the computing unit (15) configured for using the complementary signal (22) in combination with the chest signal (21) for determining the confidence criterion.

7. The system according to claim 5 or 6,
wherein the sensing unit (20) comprises a motion sensor such that the complementary signal (22) comprises a motion signal.

8. The system according to any one of claims 5 to 7,
wherein the sensing unit (20) further comprises an electrical signal measuring sensor such that the complementary signal (22) comprises an electricalsignal.

9. The system according to claim 8,
wherein the electrical signal measuring sensor comprises one of an electrocardiograph (ECG), or an impedance cardiograph (ICG) or an electromyograph (EMG).

10. The system according to any one of claims 5 to 9,
wherein the sensing unit (20) further comprises an optical sensor such that the complementary signal (22) comprises an optical signal.

11. The system according to claim 10,
wherein the optical sensor comprises one of a PPG sensor or a camera for measuring visual signal.

12. The system according to any one of claims 5 to 11,
wherein the sensing unit (20) further comprises a blood pressure sensor such that the complementary signal (22) comprises a blood pressure signal.

13. The system according to any one of claims 1 to 12,
wherein the sensing unit (20) and the control device (10) are comprised in a single device to be worn by the user.

14. The system according to any one of claims 1 to 12, wherein the control device (10) is remote from the sensing unit (20), the sensing unit (20) being configured for transmitting the chest signal (21) and the complementary signal (21) to the control device (10).

15. The system according to any one of claims 1 to 14, comprising a strap (3) comprising the sensing unit (20), the strap being configured to be worn on the user's torso such that the sensing unit (20) is in contact with the user's skin.

16. The system according to any one of claims 1 to 15, wherein the interface comprises a display unit (11) or speaker device 16 (16).

17. The system according to claim 16, wherein the interface is further configured for signaling to the user or assistant said guiding information and instructional information.

18. The system according to any one of claims 1 to 17, comprising a storage media (14) configured for storing the processed chest signal (21).

19. Method for recording signals of a user using the system according to any one of claims 1 to 18, the method comprising:

connecting the sensing unit (20) with the remote control device (10);

recording a chest signal (21);

using the remote control device (10) for generating guiding information comprising a recording procedure to follow when performing the recording;

processing the measured chest signal (21) such as to determine a confidence criterion of the chest signal (21); and

using the remote control device (10) for generating instructional information comprising information about the determined confidence

criterion to initiate and/or stop the recording or initiate a further analysis of the processed chest signal (21).

20. The method according to claim 19, wherein guiding information includes breathing guidance information.

21. The method according to claim 20, wherein guiding information includes at least one of the following actions: how to inspire, how to expire, stop breathing, move chest without breathing, cough.

22. The method according to any one of claims 19 to 21, including a step of generating initial information comprising a predetermined location where the user, or an assistant, should place the first sensor (12) on the user's chest.

23. The method according to any one of claims 19 to 22, wherein the step of initiating a further analysis comprises analyzing the processed chest signal (21) by a computer software expert

24. The method according to claim 23, wherein the computer software expert uses supervised machine-learning classification and regression techniques.

25. The method according to claim 23, wherein the step of initiating a further analysis comprises analyzing the processed chest signal (21) by an external expert.

26. The method according to claim 25, wherein the control device (10) is configured for transmitting the processed chest signal (21) to a remote server.

27. The method according to any one of claims 19 to 26, wherein the sensing unit (20) is further configured for measuring a complementary signal (22) from the user; and

wherein said processing the measured chest signal (21) uses the complementary signal (22) in combination with the chest signal (21) for determining the confidence criterion.

28. The method according to any one of claims 19 to 27, wherein the system (100) comprises a storage media (14); the method further comprising the step of storing the analyzed chest signal (21).

29. The method according to claim 28, further comprising the step of storing the initial information, guiding information and/or instructional information used for performing the recording step.

30. The method according to claim 28 or 29, comprising combining the stored chest signal (21) such as to create a database.

31. Computer medium comprising portions of code for a software application configured to be executed in the computing unit (15), when executed, said software application being configured for performing the method according to any one of claims 19 to 30.

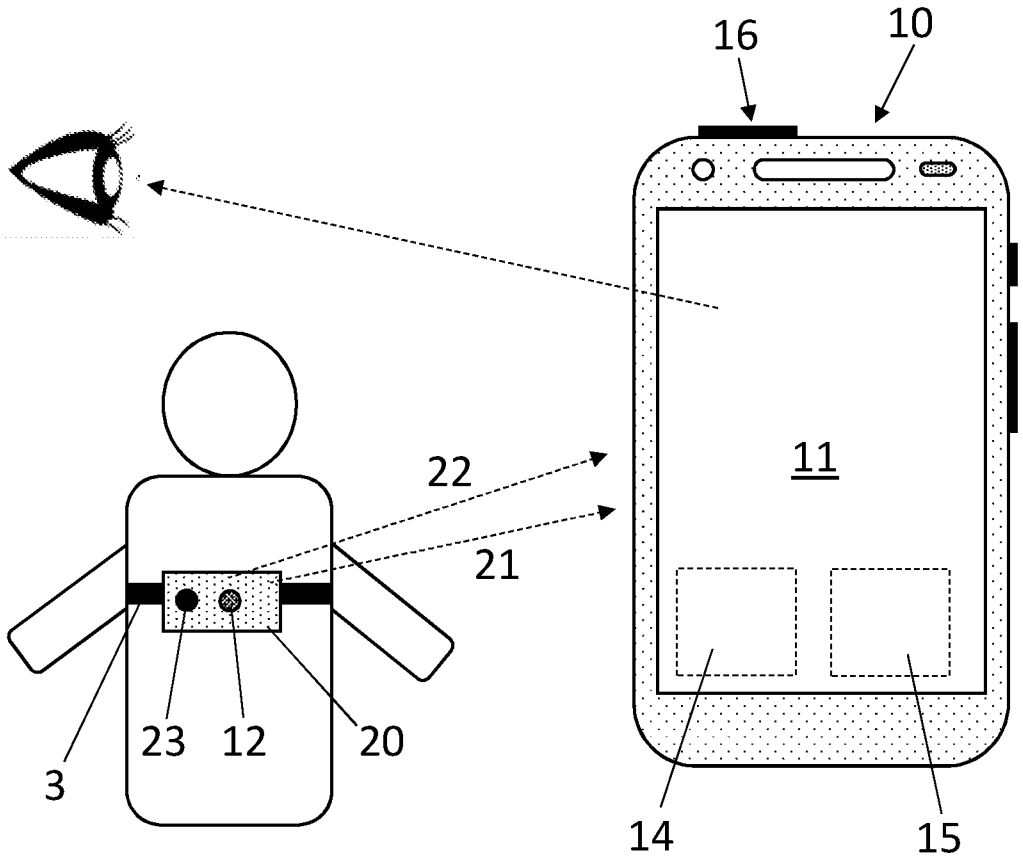

Fig. 1

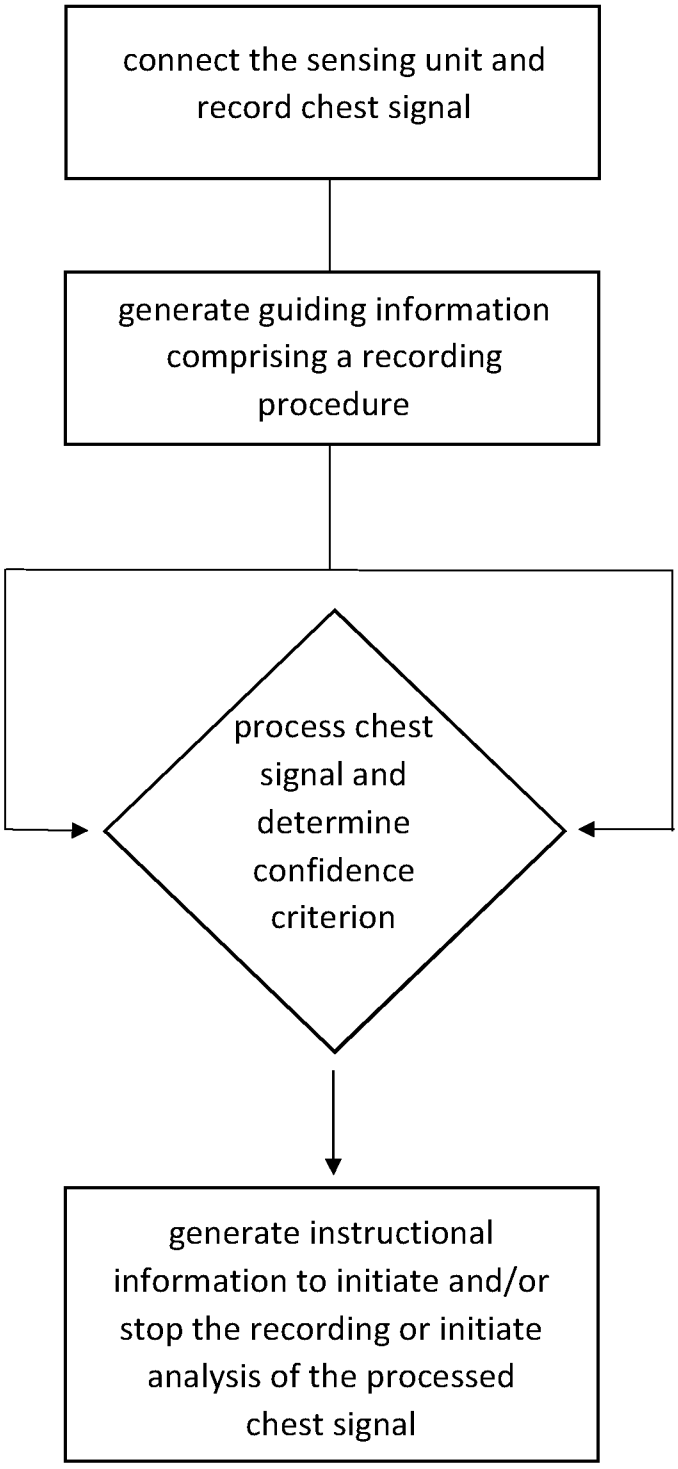
connect the sensing unit and record chest signal
generate guiding information comprising a recording procedure
process chest signal and determine confidence criterion
generate instructional information to initiate and/or stop the recording or initiate analysis of the processed chest signal

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/056263

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B7/04 G16H40/67
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B G16H G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/071565 A1 (KAHYA ZEYNEP YASEMIN [TR] ET AL) 16 March 2017 (2017-03-16) abstract; figures 1,5 paragraphs [0035], [0038], [0056], [0063], [0092] -----	1-5, 7-26, 28-31
X	US 2017/112439 A1 (DUBIN URI [IL] ET AL) 27 April 2017 (2017-04-27) abstract; figures 1,3 paragraphs [0069], [0071], [0078] - [0081], [0091] - [0099], [0118], [0120] - [0123], [0127], [0128], [0136] ----- -/--	1-6,10, 11, 14-27,31

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 May 2018	07/06/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Medeiros Gaspar, Ana

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/056263

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011/073879 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; KUMAR PRASHANT [IN]; SANJAYA KUMA) 23 June 2011 (2011-06-23) cited in the application abstract; figures 1,8 page 11, line 1 - page 12, line 16 -----	1,19,31
X	US 2004/092846 A1 (WATROUS RAYMOND L [US]) 13 May 2004 (2004-05-13) abstract; figures 1,2 paragraphs [0022], [0023], [0029], [0030], [0039], [0040] -----	1,19,31

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2017/056263

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		EP 3143536 A1	22-03-2017
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		WO 2015174944 A1	19-11-2015
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		WO 2017068573 A1	27-04-2017
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