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(54) **AN ELECTROCARDIOGRAPHIC MONITORING SYSTEM**

ELEKTROKARDIOGRAPHISCHES ÜBERWACHUNGSSYSTEM

SYSTÈME DE SURVEILLANCE D'ÉLECTROCARDIOGRAMME

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Description

Field of the Invention

[0001] The present invention relates to the field of telemedicine systems. More particularly, the invention relates to a system for capturing 12 lead ECG and rhythm strip data from a patient remotely using a telecommunication mobile device, such as iPhone.

Background of the invention

[0002] It is known that chronically ill, people or patients known to suffer from cardiac problems, and patients recovering from a surgical intervention or cardiac episode or a disease use personal ECG devices whether this on regular basis or while they don't feel well. In the prior art there are several ECG devices that can obtain a standard 12 lead ECG, such as clinical ECG machines, personal acoustic devices (e.g., CardioSen'C CardioBeeper 12L or CardioBeeper 12/12 by SHL Telemedicine). The latter personal devices adapted to be used by a non medical individual to capture a 12 lead ECG and/or Rhythm strip when the user has symptoms, routinely, as part of drug studies, pre/post surgery, etc. Although these devices do allow a user to gather some information and transfer it to remote medical data center, no ECG information is available for the user itself.

[0003] Moreover, some of the prior-art personal devices, such as the Cardiosen'C are less comfortable to carry by the user due to their overall dimensions. For example, the Cardiosen'C can communicate with a remote data center directly via its internal cellular modem. However, this takes considerable power thus a large battery and charger is required resulting in a device having relatively large dimensions. Therefore, there is also a need for a smaller device than the Cardiosen'C and the other prior-art units. With a smaller battery the device is easier to carry and therefore it is more desirable.

[0004] US Patent application No. 2010/069735 discloses a device, system and method for obtaining a 12 lead electrocardiogram (ECG) from measurements obtained with 3 electrodes in some embodiments (it should be noted that some separate embodiments of the present invention relate to such measurements with 4 electrodes). However, the solution proposed by this application is based on a handheld electrode(s) that is manipulated on the chest by a user hand. Moreover, it does not include a configuration on which the set of at least 9 skin monitoring electrodes are deployed, such that the electrodes are automatically positioned at the standard anatomical electrode locations for acquiring the standard 12-lead ECG (i.e., clinical 12-lead ECG) in accordance with precordial electrode locations that have been established by Wilson in association with Einthoven and Goldberger. Furthermore, it does not suggest the simultaneous detection of the quality of all the 6 precordial and 3 limb contacts necessary for the standard 12 lead ECG, and

therefore no real-time measurements can be obtained for generating a reliable rhythm strip.

[0005] US Patent application No. 2010/174204 discloses a device for capturing a 12-lead electrocardiogram from signals representative of the cardiac activity of a patient and acquired with the help of at least nine electrodes. The electrocardiograph comprises a body having a front face and at least one arm suitable for being folded beside the body and pivotable about an axis that is substantially parallel to the front face. Each arm is adapted to form a variable dihedral angle with the front face so that the substantially concave surface formed by the front face and the or each arm and having 6 precordial electrodes distributed thereon, is capable of adapting to the patient's morphology so as to enable the precordial electrodes to be properly positioned on the patient's chest. However, in order to obtain the readings the user needs to place his index fingers on the device, to acquire the limb lead acquisition of the ECG signals. Moreover, it is well known that finger electrodes also acquire the muscle induced electromagnetic fields (EMF) signals from the muscles of the arms, hands and fingers. This noise can obscure some small amplitude components of the ECG signal such as the "p" waves. Further this interfering noise is further aggravated by certain disease related conditions such as Parkinson's disease and tremors thus increasing this undesired noise. The use of finger electrodes occupies the user's hands during the signal acquisition periods so that it is not possible to operate communication and display devices such as Smartphones.

[0006] Moreover, US Patent application No. 2010/174204 shows the precordial or chest electrodes all in one in a straight line. However, the standard placement of precordial electrodes is specified at certain anatomical locations as setforth by Wilson and they are not in a straight line. For proper 12-lead readings, the V1 and V2 electrodes are at the same elevation and the V4, V5 and V6 are on a second horizontal line, however the V1-V2 line and line V4-V5-V6 are not at the same elevation. There is a transition from V2 to V4 which includes the V3 electrode which constitutes a third line, V2-V3-V4. As can be seen, this line is not aligned with either the V1-V2 line or the V4-V5-V6 line. Thus if all the sensing electrodes are in a straight line as depicted by this patent application, there will be some differences to a standard 12 lead electrocardiogram that adheres to the standard precordial electrode placement.

[0007] US Patent application No. US2003/0187363 shows a portable ECG device, comprising a housing supporting a plurality of chest and limb electrodes for affixing to different parts of a patient's body so as to measure the patient's rhythm strip and 12-lead ECG. An ECG signaling circuit within the housing is adapted to collect and transmit in real time fractional ECG data on at least two output channels in parallel, thereby allowing complete ECG data to be transmitted in less time than could be done by collecting and transmitting the complete ECG data serially on a single output channel in real time. Al-

though these prior art ECG devices are capable of transmitting data to remote medical data center, there still exists a need for a device that can be quickly and accurately applied to obtain a clinical 12 lead ECG and rhythm strip. There also still exists a need for such a system which is reliable in use and is user-friendly. There further exists a need for a personal ECG device which can be used in combination with existing portable computer based communication devices (e.g., a mobile cellphone or a smartphone) for enhancing the interaction between the remote medical data center the personal ECG device and the user itself.

[0008] It is an object of the present invention to overcome the drawbacks of the prior-art devices and to fulfill the aforementioned needs. The present invention is particularly aimed at ill people or patients known to suffer from cardiac problems, and patients recovering from a surgical intervention or cardiac episode or a disease.

[0009] It is another object of the present invention to provide a system which is capable of remotely communicate with a data center.

[0010] It is yet another object of the present invention to provide a system which is capable of locally displaying ECG related activity information to the user including the quality of the electrode contact and other relevant information (e.g., guidance and instructions for the user during and/or after the use).

[0011] Other objects and advantages of the invention will become apparent as the description proceeds.

Summary of the Invention

[0012] The present invention relates to an electrocardiographic monitoring system, which comprises: a) a personal ECG device for providing 12-lead electrocardiogram data that represents the electrical activity of a user's heart, wherein said 12-lead electrocardiogram obtained from a set of at least 9 skin electrodes each of which is electrically connected to said personal ECG device, either directly or via a chest electrode belt; b) a short range wireless communication module embedded within said personal ECG device for data communicating with a smartphone; and c) a dedicated smartphone application for being executed by said smartphone, for visually displaying information related to said provided 12-lead electrocardiogram and for data communicating with a remote data center. A system according to the invention is defined in claim 1. According to an embodiment of the present invention, the electrode belt includes a chest strap with 6 anatomically positioned precordial ECG electrodes, Right/Left Arm electrodes, an elastic portion to extend around the chest and a unique, convenient closure containing electrical connections. Optionally, the electrode belt can be detached from the personal ECG device and replaced by various belts to personalize belt size to chest size and gender.

[0013] According to an embodiment of the present invention, the personal ECG device is configured in such

a way that it is capable of storing at least one retractable ECG electrode (i.e., the waist electrode that is placed at the waist or belt line positioned halfway from the naval to the left hip) and its conductive wire within its housing to conserve space. According to some embodiments, the electrode is a spool with an outside electrically conductive electrode surface to allow the winding of the wire into the housing of the personal ECG device similar to a child's YOYO. Alternatively the retractable ECG electrode is provided with a retracting means to store the wire, such as a spring or alternative device within the housing of the personal ECG device to retract the wire inside for compact storage.

Brief Description of the Drawings

[0014] In the drawings:

- Fig. 1 schematically illustrates a layout of the personal ECG electrocardiographic monitoring system, according to an embodiment of the present invention;
- Figs. 2 schematically illustrates a front view of a personal ECG device, according to an embodiment of the present invention;
- Figs. 3 schematically illustrates a rear view of the personal ECG device of Fig. 2;
- Fig. 4 schematically illustrates an electronic block diagram of the personal ECG device, according to an embodiment of the present invention;
- Fig. 5 schematically illustrates a front view of a personal ECG device provided with an electrodes belt, according to an embodiment of the present invention;
- Fig. 6 schematically illustrates a rear view of the personal ECG device of Fig. 5; and
- Figs. 7-11 schematically illustrate example Smartphone screen layouts of a dedicated application to be used with the personal ECG device, according to an embodiment of the present invention.

Detailed Description of the Invention

[0015] The following description relates to embodiments of an electrocardiographic (ECG) monitoring system and method of the present invention by way of illustration only. It should be noted that from the following discussion, alternative embodiments of the structures and methods disclosed herein will be readily recognized as viable alternatives that may be employed without departing from the principles of the claimed invention. The invention being defined by the appended claims 1-5. Reference will now be made to several embodiments of the present invention(s), examples of which are illustrated in the accompanying figures. Wherever practicable similar or like reference numbers may be used in the figures and may indicate similar or like functionality. As aforementioned hereinabove, the figures depict embodiments of

the present invention for purposes of illustration only.

[0016] Unless otherwise indicated, the functions described herein may be performed by executable code and instructions stored in computer readable medium and running on one or more processor-based systems as defined in claim 1. However, hardwired electronic circuits can also be utilized. Further, with respect to the example processes described herein, not all the process states need to be reached, nor do the states have to be performed in the illustrated order. Further, certain process states that are illustrated as being serially performed can be performed in parallel.

[0017] Similarly, while certain examples may refer to a smartphone, other computer or electronic systems can be used as well, such as, without limitation, a network-enabled personal digital assistant (PDA), computer, communication hub or data device with an operating system and on which a user can install applications and so on.

[0018] In addition, while certain user inputs or gestures are described as being provided via phone key presses, data entry via a keyboard, the use of touch screens or by clicking a button, optionally, user inputs can be provided using other techniques, such as by voice or otherwise.

[0019] Fig. 1 schematically illustrates a layout of an ECG monitoring system 10, according to an embodiment of the present invention. System 10 enables an individual to immediately gather and transmit 12-lead ECG and a rhythm strip data to a remote unit or to any required destination. The system 10 provides data which represents the electrical activity of the heart. The 12 Lead ECG defines the graphic representation of the electrical activity of the heart from various anatomical locations of the body. The electrical activity of the heart recorded over time is called a rhythm strip. The system 10 and its components are described in further details herein below.

[0020] System 10 comprises three main components: a personal ECG device 1, an application installed on a suitable mobile communication device 2 (e.g., an iPhone application) and a remote data center 3 with a dedicated software (e.g., the SHL medical monitoring center of SHL Telemedicine, remote medical center, or any other data center).

[0021] The personal ECG device 1 comprises skin electrodes and electronic components which are used for real-time transmission of the electrical activity of the heart as acquired by the skin electrodes. Device 1 transmits the data representing the electrical activity of the heart via a wireless communication link (e.g., via Bluetooth) to the mobile communication device 2.

[0022] According to an embodiment of the present invention, the electrocardiogram is constructed in the remote data center 3. The construction of the ECG and the operation of the remote data center 3 involve the following tasks:

- receiving ECG data packets (from the mobile com-

munication device) and performing error checking (by using any suitable error control technique that enables reliable delivery of digital data over communication channels);

- 5 - processing the ECG data and creating a 12 lead ECG and/or Rhythm strip record;
- storing the ECG records; and
- 10 - upon request, sending ECG records and/or other related data in a variety of forms to other data devices (e.g., fax, email, printer, mobile phone, smartphone, etc).

[0023] In some uses, it is advantageous for the user to be able to capture and visualize their own ECG and then forward it to their doctor or another medical facility. By utilizing a smartphone, the system 10 of the present invention allows the user to acquire the ECG, visualize the ECG (as delivered from the remote data center 3) on a smartphone and further, utilizing the smartphone allows the user to forward the electrocardiogram to a medical expert, his own doctor, or to a remote facility for analysis and/or advice.

[0024] According to some embodiments of the invention, ECG related activity can be conveyed to the user via the display unit of the smartphone. These may further include indication regarding the quality of the electrode contact and other relevant information (e.g., guidance and instructions for the user during and/or after the use), to be discussed in greater details below.

[0025] Figs. 2 and 3 show a personal ECG device 1 that can be used in conjunction with the invention. The device 1 illustrated in this figures is particularly convenient because it has a relatively small dimension and wherein its housing 11 is configured in such a way that it contains on its front panel a visual indicator 12 (e.g., in form of a glowing heart), which displays the status of the personal ECG device 1. Device 1 further comprises a "start" button 13 which used for turning "on" (or "off") the personal ECG device 1 (e.g., the "start" button can be located adjacent to the visual indicator 12). Preferably, the visual indicator 12 should be located on the front side of the housing of the personal ECG device 1 or on other location that will be seen easily by the user. This visual indicator 12 displays the status of the personal ECG device 1, whether it is turned on, measuring or has an error.

[0026] Device 1 further comprises a set of skin electrodes, wherein some of them are deployed along an electrode belt 16 (such as the exemplary electrodes indicated by numerals 21, 22 and 23), while other electrodes V1 and V2 are attached to the rear side of the housing 11 (see Fig. 3).

[0027] According to an embodiment of the invention, the device 1 also comprises a waist electrode 14 that is electrically connected to device 1 through a novel and unique retractable mechanism (i.e., a yoyo-like mechanism), as will be described in further herein after. The housing 11 of device 1 includes a compartment 20 adapted to store the waist electrode 14 while it is not in use.

In this embodiment, the compartment 20 is located at the rear side of the housing 11, as easily seen in Fig. 3. This arrangement provides a compact and comfortable solution to the storage of the waist electrode 14. Another advantage of the present invention over the prior-art devices is that the waist electrode 14 can easily and automatically be returned into its storage compartment 20 after the use, due to the retractable mechanism.

[0028] In this embodiment, the rear side of the housing 11 has two electrodes (precordial electrodes V1 and V2). The housing 11 should be placed against the center of the user's chest. The housing's ergonomic design ensures the correct positioning of the electrodes V1 and V2 against the chest, while affording the user maximum comfort with minimal exertion when operating the device.

[0029] The device 1 further comprises a belt closure 18 for closing the belt 16, while it surrounds the body of the user. According to an embodiment of the invention, in addition to the mechanical attachment, the buckle of belt 16 and the belt closure are also electrically connected. For example, electrical wirings (not shown) can be used to connect each of the skin electrodes 21-23 (that are deployed along belt 16) to the buckle 19 of belt 16, while the electrical connection between the belt's buckle 19 and the belt closure 18 allows to transfer the electrical activity of the heart as acquired by the skin electrodes 21-23 to the electronic components of device 1.

[0030] The personal ECG device 1 is powered by a power source such as one or more batteries. For example, the batteries can be 2 lithium "AAA" batteries. Alternatively, alkaline batteries can also be used.

[0031] Referring now to Fig. 4, a schematic layout of the electronic components within the housing 11 of the personal ECG device 1 is shown in accordance with an embodiment of the present invention. The electronic components that are located inside the housing 11 of device 1 are divided to two main electronic modules: an analog module 32 and a digital module 33.

[0032] The analog module 32 contains signal conditioning circuitry to acquire the low level electrical signals from the electrodes 31. The signals from the electrodes 31 are acquired in such a manner to obtain the data for the standard Einthoven limb leads, the Goldberger augmented leads and the Wilson precordial leads which comprise the standard 12 lead electrocardiogram. For example, the signal condition circuitry may include typical electronic components for amplifying the low level electrical signals from the electrodes 31 and to convert them into a digital form, such as input amplifiers, analog to digital converters, filters, and/or other components that can be used to manipulate analog signals.

[0033] The digital module 33 digitizes the electrocardiographic signals. Further this module also provides the two way wireless communication protocol to convey all the digital data to and from the mobile communication device 2 (e.g., a wireless communication between the device 1 and an iPhone, iPad, iTouch, other smartphones or wireless communication devices via a Bluetooth (BT)

module 36 or other wireless protocol). Device 1 further comprises a User Interface (UI) 34 or other Man Machine Interface, which may include one or more visual indicator (e.g., the glowing heart 12) and/or other display unit (e.g., LCD panel), one or more functional button (e.g., such as the start button 13), etc..

[0034] One of the advantages of the personal ECG device of the present invention with respect to prior-art devices is that it needs to transmit data to a paired and relatively adjacent portable communication device, such as a smartphone (using short range data communication protocol, e.g., Bluetooth). Short range transmissions reduce power consumption. Accordingly, the personal ECG device requires a smaller battery, which leads to its relatively smaller dimensions (e.g., about 8.5cm width, 11cm length and 1.5cm height). A smaller battery also results in a lighter unit (e.g., about 100g). Lower power consumption also allows the practical use of disposable batteries, eliminating the need for a recharger with cable. All these factors further reduce the size and weight of a user's carrying/storage package.

Electrodes

[0035] The device housing and belt contain electrodes (i.e., set of skin electrodes) for acquiring electrical signals from the conventional anatomic electrode locations for a 12 lead electrocardiogram from the chest and limbs. For example, the electrodes can be made from PC ABS + 20% glass fiber with a coating of silver/silver chloride (Ag/AgCl).

[0036] Usually several electrodes are used and they can be combined into a number of pairs (e.g., left arm and right arm electrodes). The output from each combination is known as a lead. Each lead is said to look at the heart from a different angle. A 12-lead ECG is a recording of the heart's electrical activity from 9 anatomical located electrodes on the body which are combined to produce a conventional clinical 12-lead record.

[0037] Referring now to Figs. 5 and 6, a personal ECG device with electrodes belt is shown in accordance with an embodiment of the present invention. In this embodiment, the electrodes Location deployed as follows: two electrodes are located on the housing (indicated by V1 & V2), four precordial electrodes are located on the left electrode belt (indicated by V3 to V6, two limb electrodes consisting of Left Arm (LA), Right Arm (RA) belt mounted electrodes and a flying lead Left Leg (LL) (waist) retractable limb electrode (i.e., the waist electrode 14 with the yoyo-like mechanism (not shown in rear view fig, 4)) attached via a conductive wire.

[0038] According to an embodiment of the present invention, the belt can be detached from the housing of the personal ECG device. For example, there can be plurality of belts sizes in order to accommodate variety of chest sizes, wherein each one of them is designed for a specific gender and body size. By replacing the belt, the personal ECG device can fit all users. To accommodate different

chest sizes, different belts with strategically positioned electrodes can be used for each gender.

[0039] According to an embodiment of the present invention, the electrode belt comprises a dual purpose belt closure: An interlocking fastener is attached to the belt. This permits the user to mechanically attach the end of the chest belt to the housing. Further, this fastener contains electrical contacts to electrically connect some belt monitoring electrodes to the electronics of the device as will be described in further details herein after in the electrodes belt section.

[0040] According to an embodiment of the present invention, the personal ECG device is provided with a dual proposes belt closure (as shown in Figs. 5 and 6). The electrode belt includes electrical wiring for electrically contacting the electrodes via the belt closure to the electronics of the personal ECG device.

[0041] In this embodiment, the electrode belt is an elastic chest strap which comprises 6 precordial ECG electrodes, Right/Left Arm electrodes (indicated by RA and LA in Fig. 5) and a unique, convenient belt closure 18 containing electrical connections to electrically connect with buckle 19 (in addition to their mechanical engagement while fastening the belt around the user's chest).

[0042] In general, in order to obtain a 12 lead electrocardiogram, at least 9 electrodes are required to be positioned on the user's body. Six of the electrodes are precordial electrodes that a positioned at certain anatomical electrode locations on the chest (as indicated by electrodes V1-V6 in Fig. 6). The remaining 3 electrodes are limb electrodes monitor the electrical signals on the left arm (LA electrode), right arm (RA electrode) and the left leg (i.e., the retractable waist electrode). For simplicity of use, as aforementioned herein before the personal ECG device has 2 precordial, chest-facing electrodes on the electronic enclosure case (i.e., on the rear side of the housing) and the remaining 4 precordial electrodes are on the belt itself. In addition, two limb electrodes Right Arm (RA) and Left Arm (LA) outward facing electrodes. To easily apply the elastic belt, the electrode belt is permanently attached to the electronic enclosure and the other end is fitted with a novel closure/snap. In this way, when the mechanical belt fastener is engaged with the case, an electrical connection is also achieved to the RA sensing electrodes.

[0043] According to an embodiment of the invention, the electrodes belt further includes a body reference electrode as indicated by numeral 27 in Fig. 6. The body reference electrode 27 provides a reference for the input amplifiers of the signal conditioning circuitry, which contributes to reduction of mains noise and better performance.

[0044] For example, the electrodes belt can be made from neoprene covered with Nylon fabric which is the same material utilized for wet suits. This is a comfortable and soft material, ideal for repeated flexing applications. Two electrodes belts are connected with stretch belt.

[0045] The left part of the electrode belt is permanently

attached to the left side of the housing and contains seven electrodes: five electrodes (4 precordial monitoring electrodes and one amplifier reference electrode) on the inside of the belt and a further two limb electrodes (i.e., a duplication of electrodes to monitor LA (Left Arm)) on the outside. The right part of the electrode belt contain two electrodes on the outside, both are for the RA right arm connection. The right electrode belt has a double contact buckle that insures good electrical connection between the electrodes and the housing. The two parts of the electrode belt are connected with stretch belt between them. To accommodate different chest sizes, there are different size belts. The belts have electrodes positioned in the optimal position for each chest size.

YOYO "flying" electrode

[0046] According to an embodiment of the present invention, the personal ECG device further comprises an electrode attached with wire to the bottom of the housing (referred to as "flying" electrode). This "flying" electrode is labeled 'waist', referring to where it should be placed. The flying ('waist') is positioned at the user's belt line against the bare skin, halfway from the navel to the left hip. Together with the electrodes on the front of the electrode belts, these make up the three limb electrodes. The limb electrodes and the other electrodes on the belt in combination with those on the housing device permit the acquisition of ECG data for a rhythm strip and 12 lead ECG for remote interpretation by a qualified healthcare professional.

[0047] The flying electrode has wire a spool or retractor that collect the entire waist electrode wire to the electrode compartment. Using this retractor enables the compact packing of the waist electrode. When the device is not in use, there is no electrode wire hanging outside the housing as occur in prior art devices.

[0048] The outer plastic of the flying electrode may have a conductive coating to reduce electrical noise. The electrode wire connects with a spring to the plastic with good conductivity.

Smartphone Application

[0049] The example screen layouts, appearance, and terminology of Smartphone application as depicted and described herein with respect to Figs 7-11, are intended to be illustrative and exemplary, and in no way limit the scope of the invention as claimed. The invention being entirely defined by the appended claims 1-5. The application may include the following options or application menus: Symptoms menus - the application can display menus of predefined selectable symptoms so that the user can select any present symptoms. Perform an ECG - This permit selecting symptoms and recording an ECG including a screen to display the electrode status and guide the user in how to position the electrodes. Fig. 7 shows a graphical example screen of a symptom menu

of the smartphone application.

[0050] Electrodes Contact Quality Display - Fig. 8 shows a graphical example of electrodes contact quality screen of the smartphone application. This screen displays the contact status of the electrodes and will guide the user to correctly position the electrodes in order to improve the contact of the electrodes with the user's body, for example, by displaying visual messages on the displayed image of the human chest (when the personal ECG device is not position correctly), such as "position waist electrode tightly against your skin", "attach device to chest", "tighten strap", etc.

[0051] ECG recording progress - Fig. 9 shows a graphical example of the ECG perform starting screen of the smartphone application. This screen shows an indication that all the electrodes are in contact (i.e., which is an essential information before the beginning of the recording progress).

[0052] Viewing ECGs - Fig. 10 shows a graphical example of recorded ECGs screen of the smartphone application. This screen permits the viewing of the recorded ECGs.

[0053] Sending ECG - Fig. 11 shows a graphical example of Send ECGs screen of the smartphone application. This screen permits the forwarding of ECGs, e.g., via e-mail or fax.

[0054] Help Function - This includes training information for using the personal ECG device, using the smartphone application and information about the symptoms.

Claims

1. An electrocardiographic monitoring system for obtaining a 12-lead electrocardiogram (ECG) and a rhythm strip, comprising:

- a personal ECG device (1) having a housing (11) that includes an analog module (32) adapted for acquiring low level electrical signals from skin monitoring electrodes (31), a digital module (33) for converting the acquired signals into digital data form, and a communication module for wirelessly communication between said personal ECG device (1) and a mobile communication device (2), thereby enabling to convey data between both devices including the transferring of said converted digital data to said mobile communication device (2);
- a dedicated application for being executed by said mobile device, for data communicating with a remote data center in order to transmit the data to said remote data center for processing said data and creating a 12-lead ECG and rhythm strip record

characterized in that the system further comprises

- 9 skin monitoring electrodes suitable to be po-

sitioned on the body of a user in a conventional anatomic electrode locations for a 12-lead ECG from the chest and limbs, in accordance with Einthoven, Goldberger and Wilson, wherein said conventional anatomic electrode locations are obtained by deploying said electrodes along a belt (16) connected with said personal ECG device (1) and on the housing (11) of said personal ECG device (1), wherein at least four of said electrodes (V3-V6) are chest-facing precordial electrodes that are located on the inside of said belt and are for positioning on the chest of said user, two electrodes (LA, RA) are belt mounted outward facing limb electrodes located on the outside of said belt (16) to acquire electrical signals of the left arm electrode (LA) and the right arm electrode (RA), 1 flying electrode (LL) suitable to acquire the electrical signals of the left leg of said user, and two additional chest-facing precordial electrodes (V1, V2) are located on the housing of said personal ECG device.

2. A system according to claim 1, in which the housing includes a belt closure (18) arrangement for mechanically securing the belt (16) while it surrounds the body of the user, and for electrically connecting at least some of the electrodes of said belt (16) to the analog module (32).
3. A system according to claim 1, in which the mobile communication device (2) establishes data communication with the remote data center (3) while in voice contact with a representative of said remote data center.
4. A system according to claim 1, in which the wireless communication between the personal ECG device (1) and the mobile communication device (2) enables a user to improve the contact quality of the electrodes by using the mobile communication device to display the contact quality of each skin monitoring electrode, thereby providing feedback to the user to evaluate the quality of the electrode contact and permitting said user to improve the contact and thus the quality of the resulting ECG.
5. A system according to claim 1, in which the mobile communication device (2) provides instructions, questions, or other relevant data to a user while operating the personal ECG device (1).

Patentansprüche

1. Elektrokardiographisches Überwachungssystem zum Erhalten eines 12-Kanal-Elektrokardiogramms (EKG) und eines Rhythmusstreifens, umfassend:

- eine persönliche EKG-Vorrichtung (1) mit einem Gehäuse (11), das ein analoges Modul (32) umfasst, eingerichtet zum Erfassen schwacher elektrischer Signale von Hautelektroden für die Überwachung (31), ein digitales Modul (33) zum Umwandeln der erfassten Signale in eine digitale Datenform und ein Kommunikationsmodul zur drahtlosen Kommunikation zwischen der persönlichen EKG-Vorrichtung (1) und einer tragbaren Kommunikationsvorrichtung (2), wodurch es ermöglicht wird, Daten zwischen beiden Vorrichtungen zu übermitteln, einschließlich das Übertragen der umgewandelten digitalen Daten an die tragbare Kommunikationsvorrichtung (2);

- eine dedizierte, durch die tragbare Vorrichtung auszuführende Anwendung zur Datenkommunikation mit einem Remote-Rechenzentrum, um die Daten an das Remote-Rechenzentrum für das Verarbeiten der Daten, das Erzeugen eines 12-Kanal-EKGs und das Aufzeichnen eines Rhythmusstreifens zu übertragen

dadurch gekennzeichnet, dass das System ferner Folgendes umfasst:

- 9 Hautelektroden zur Überwachung, die dazu geeignet sind, auf dem Körper eines Anwenders an herkömmlichen anatomischen Elektrodenpositionen für ein 12-Kanal-EKG von Brust und Gliedmaßen gemäß Einthoven, Goldberger und Wilson angeordnet zu werden, wobei die herkömmlichen anatomischen Elektrodenpositionen erhalten werden durch Einsetzen der Elektroden längs eines Gürtels (16), der mit der persönlichen EKG-Vorrichtung (1) und dem Gehäuse (11) der persönlichen EKG-Vorrichtung (1) verbunden ist, wobei wenigstens vier der Elektroden (V3-V6) der Brust zugewandte Präkordialelektroden sind, die auf der Innenseite des Gürtels angeordnet und für die Positionierung auf der Brust des Anwenders vorgesehen sind, wobei zwei Elektroden (LA, RA) am Gürtel angebrachte, nach außen gerichtete Gliedmaßen-elektroden sind, die auf der Außenseite des Gürtels (16) angebracht werden, um elektrische Signale der linken Armelektrode (LA) und der rechten Armelektrode (RA) zu erfassen, wobei 1 fliegende Elektrode (LL) dazu geeignet ist, die elektrischen Signale des linken Beins des Anwenders zu erfassen, und zwei zusätzliche, der Brust zugewandte Präkordialelektroden (V1, V2) auf dem Gehäuse der persönlichen EKG-Vorrichtung angeordnet sind.

2. System nach Anspruch 1, wobei das Gehäuse eine Anordnung für einen Gürtelverschluss (18) zum mechanischen Sichern des Gürtels (16) umfasst, wenn

dieser den Körper des Anwenders umgibt, und zur elektrischen Verbindung wenigstens einer der Elektroden des Gürtels (16) längs des analogen Moduls (32).

3. System nach Anspruch 1, wobei die tragbare Kommunikationsvorrichtung (2) eine Datenkommunikation mit dem Remote-Rechenzentrum (3) aufbaut, während sie in Sprechkontakt mit einem Vertreter des Remote-Rechenzentrums steht.
4. System nach Anspruch 1, wobei die drahtlose Kommunikation zwischen der persönlichen EKG-Vorrichtung (1) und der tragbaren Kommunikationsvorrichtung (2) es einem Anwender ermöglicht, die Kontaktqualität der Elektroden zu verbessern, indem die tragbare Kommunikationsvorrichtung zur Anzeige der Kontaktqualität einer jeden Hautelektrode zur Überwachung angezeigt wird, wodurch eine Rückmeldung an den Anwender bereitgestellt wird, um die Qualität des Elektrodenkontakts zu beurteilen und es dem Anwender zu ermöglichen, den Kontakt und folglich die Qualität des sich daraus ergebenden EKGs zu verbessern.
5. System nach Anspruch 1, wobei die tragbare Kommunikationsvorrichtung (2) einem Anwender während des Betriebs der tragbaren EKG-Vorrichtung (1) Anleitungen, Fragen oder andere relevante Daten bereitstellt.

Revendications

1. Système de surveillance d'électrocardiogramme pour obtenir un électrocardiogramme (ECG) à 12 dérivations et une bande de rythme, comprenant :
 - un dispositif EGC personnel (1) comportant un boîtier (11) qui comprend un module analogique (32) adapté pour acquérir des signaux électriques de faible niveau à partir d'électrodes de surveillance de peau (31), un module numérique (33) pour convertir les signaux acquis sous forme de données numériques, et un module de communication pour une communication sans fil entre ledit dispositif EGC personnel (1) et un dispositif de communication mobile (2), en permettant ainsi d'acheminer des données entre les deux dispositifs, comprenant le transfert des dites données numériques converties audit dispositif de communication mobile (2);
 - une application dédiée destinée à être exécutée par ledit dispositif mobile, pour une communication de données avec un centre de données à distance de manière à transmettre les données audit centre de données à distance pour le traitement des dites données et la création

- d'un enregistrement d'ECG à 12 dérivations et de bande de rythme,
caractérisé en ce que le système comprend en outre
- 9 électrodes de surveillance de peau adaptées pour être positionnées sur le corps d'un utilisateur dans des emplacements d'électrode anatomiques conventionnels pour un ECG à 12 dérivations à partir de la poitrine et des membres, selon Einthoven, Goldberger et Wilson, dans lequel lesdits emplacements d'électrode anatomiques conventionnels sont obtenus en déployant lesdites électrodes le long d'une courroie (16) connectée audit dispositif ECG personnel (1) et sur le boîtier (11) dudit dispositif ECG personnel (1), dans lequel au moins quatre desdites électrodes (V3-V6) sont des électrodes précordiales orientées vers la poitrine qui sont situées sur le côté intérieur de ladite courroie et adaptées pour le positionnement sur la poitrine dudit utilisateur, deux électrodes (LA, RA) sont des électrodes de membre orientées vers l'extérieur et montées sur la courroie, situées sur le côté extérieur de ladite courroie (16) pour acquérir des signaux électriques de l'électrode du bras gauche (LA) et de l'électrode du bras droit (RA), 1 électrode volante (LL) adaptée pour acquérir les signaux électriques de la jambe gauche dudit utilisateur, et deux électrodes précordiales orientées vers la poitrine additionnelles (V1, V2) sont situées sur le boîtier dudit dispositif ECG personnel.
2. Système selon la revendication 1, dans lequel le boîtier comprend un agencement de fermeture de courroie (18) pour fixer mécaniquement la courroie (16) alors qu'elle entoure le corps de l'utilisateur, et pour connecter électriquement au moins certaines des électrodes de ladite courroie (16) au module analogique (32).
 3. Système selon la revendication 1, dans lequel le dispositif de communication mobile (2) établit une communication de données avec le centre de données à distance (3) tout en étant en contact vocal avec un représentant dudit centre de données à distance.
 4. Système selon la revendication 1, dans lequel la communication sans fil entre le dispositif ECG personnel (1) et le dispositif de communication mobile (2) permet à un utilisateur d'améliorer la qualité de contact des électrodes en utilisant le dispositif de communication mobile pour afficher la qualité de contact de chaque électrode de surveillance de peau, en fournissant ainsi une rétroaction à l'utilisateur pour évaluer la qualité du contact d'électrode et permettre audit utilisateur d'améliorer le contact et ainsi la qualité de l'ECG résultant.
 5. Système selon la revendication 1, dans lequel le dispositif de communication mobile (2) fournit des instructions, des questions ou d'autres données pertinentes à un utilisateur durant le fonctionnement du dispositif ECG personnel (1).

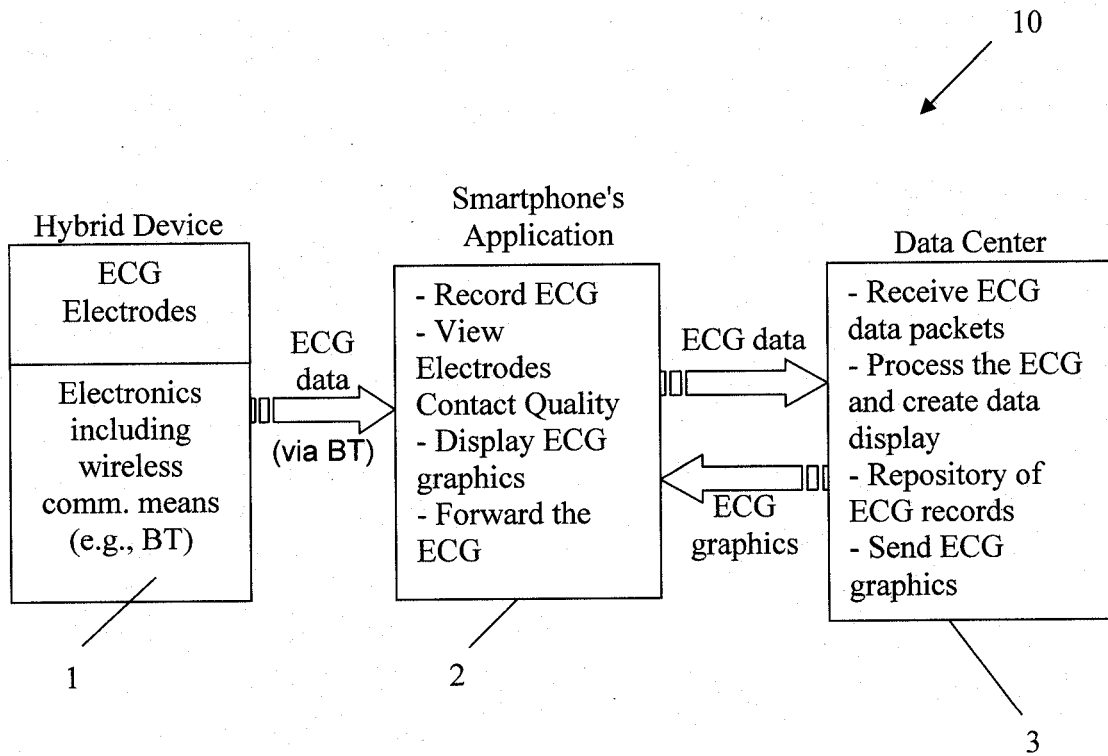


Fig. 1

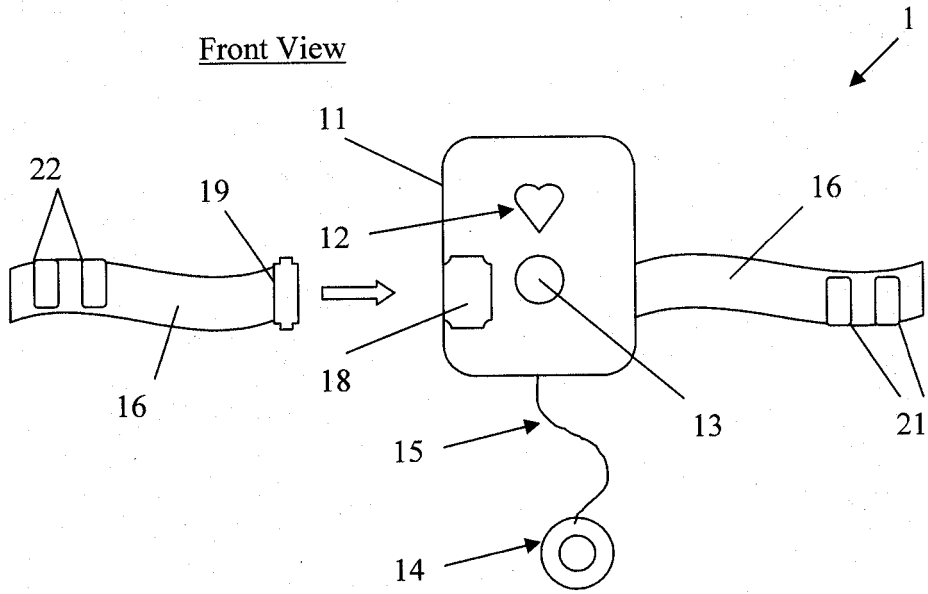


Fig. 2

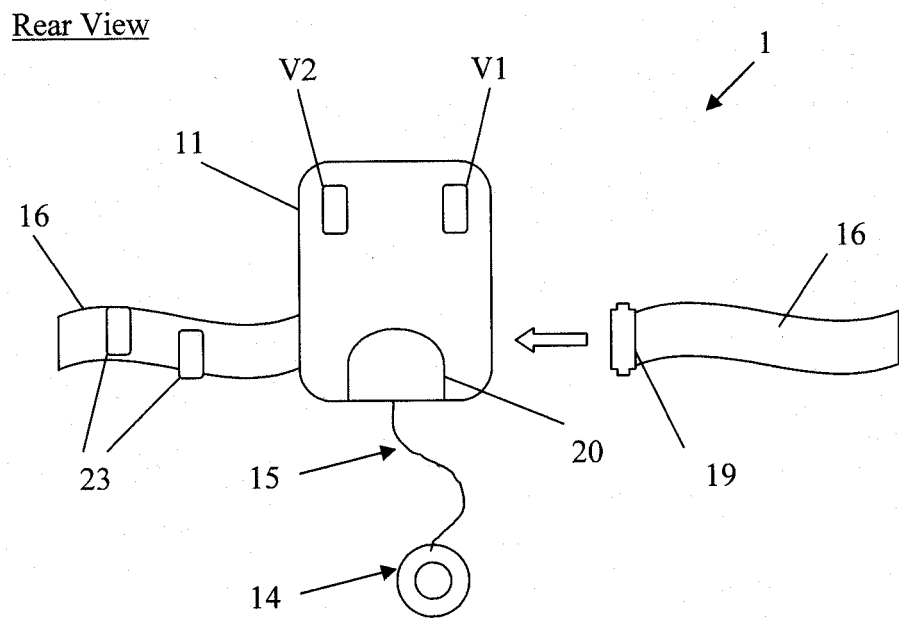


Fig. 3

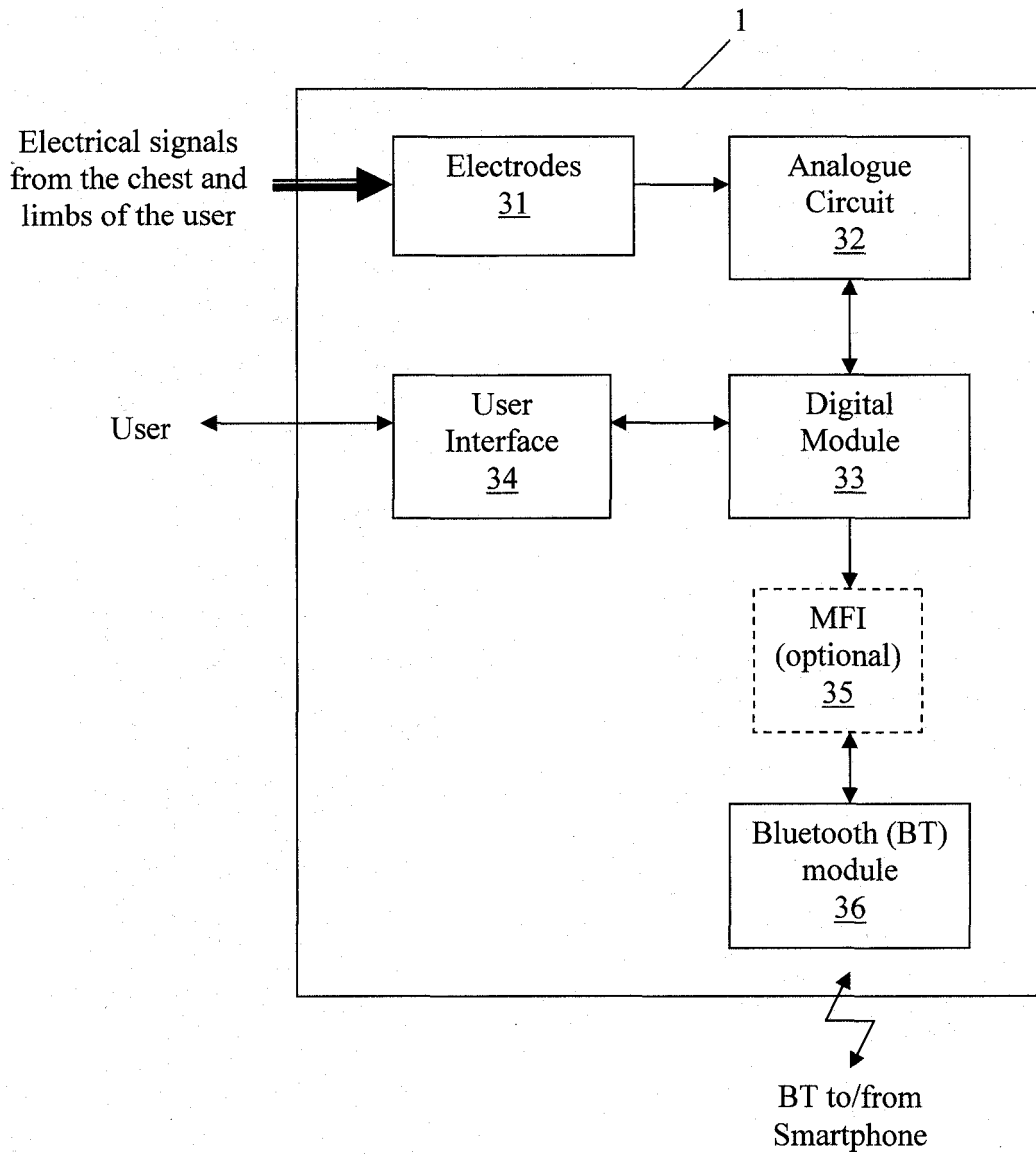


Fig. 4

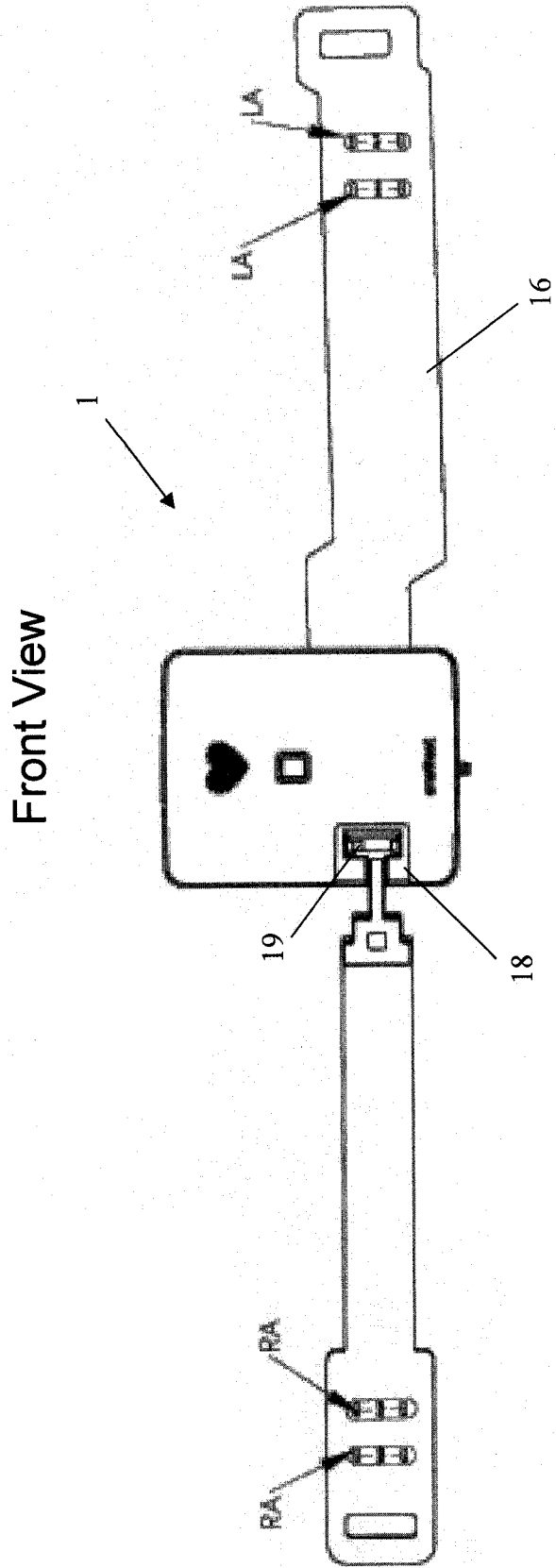


Fig. 5

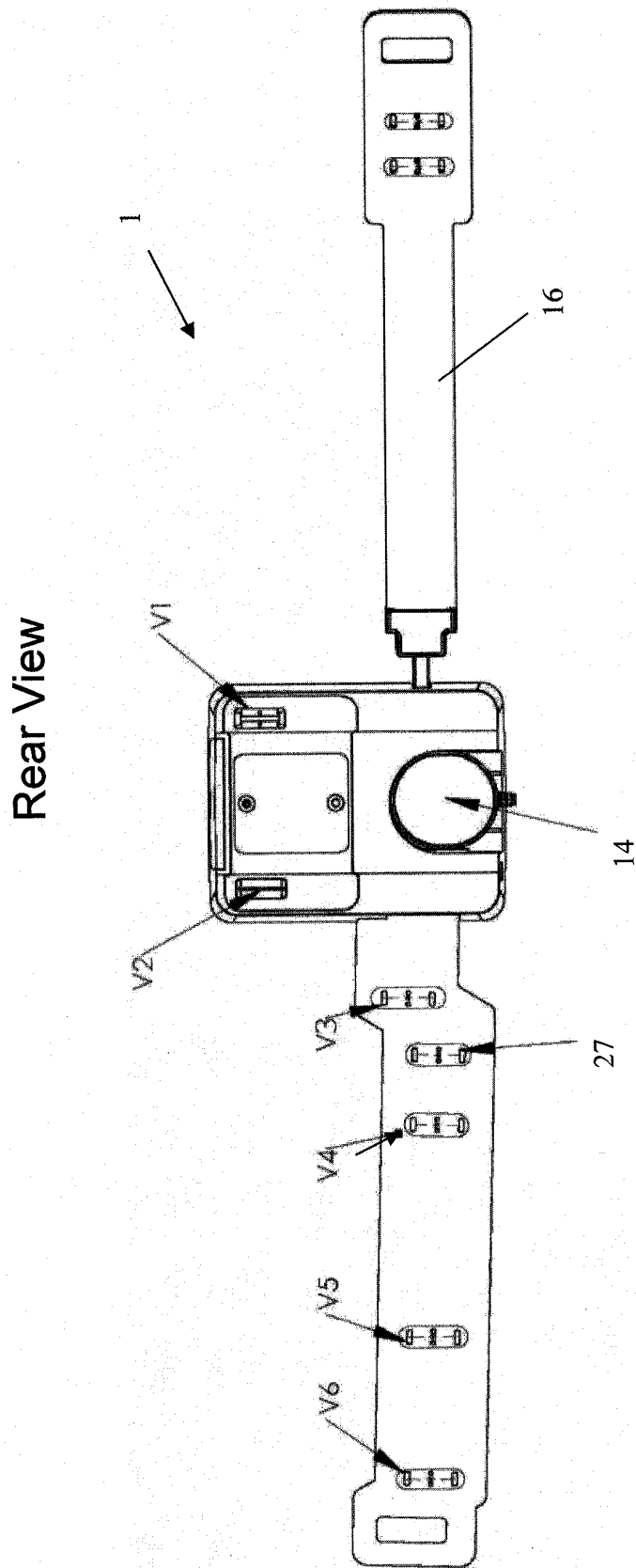


Fig. 6

Symptoms

The image shows a mobile application interface for a 'Symptoms' form. At the top, there is a dark header bar with a 'Main' button on the left and the title 'Symptoms' in the center. Below the header is a list of symptoms, each in a separate row. The first row is a toggle switch for 'Any Symptoms?', which is currently set to 'Yes'. The following rows are: 'Chest pain', 'Chest Discomfort', 'Palpitations' (with a checkmark), 'Butterflies in Chest', 'Shortness of Breath', 'Cough' (with a checkmark), and 'Upper Back Pain'. At the bottom of the screen is a grey bar containing a circular icon with a question mark and the word 'Help' below it.

Symptom	Status
Any Symptoms?	Yes
Chest pain	
Chest Discomfort	
Palpitations	✓
Butterflies in Chest	
Shortness of Breath	
Cough	✓
Upper Back Pain	

Fig. 7

Electrodes Positioning

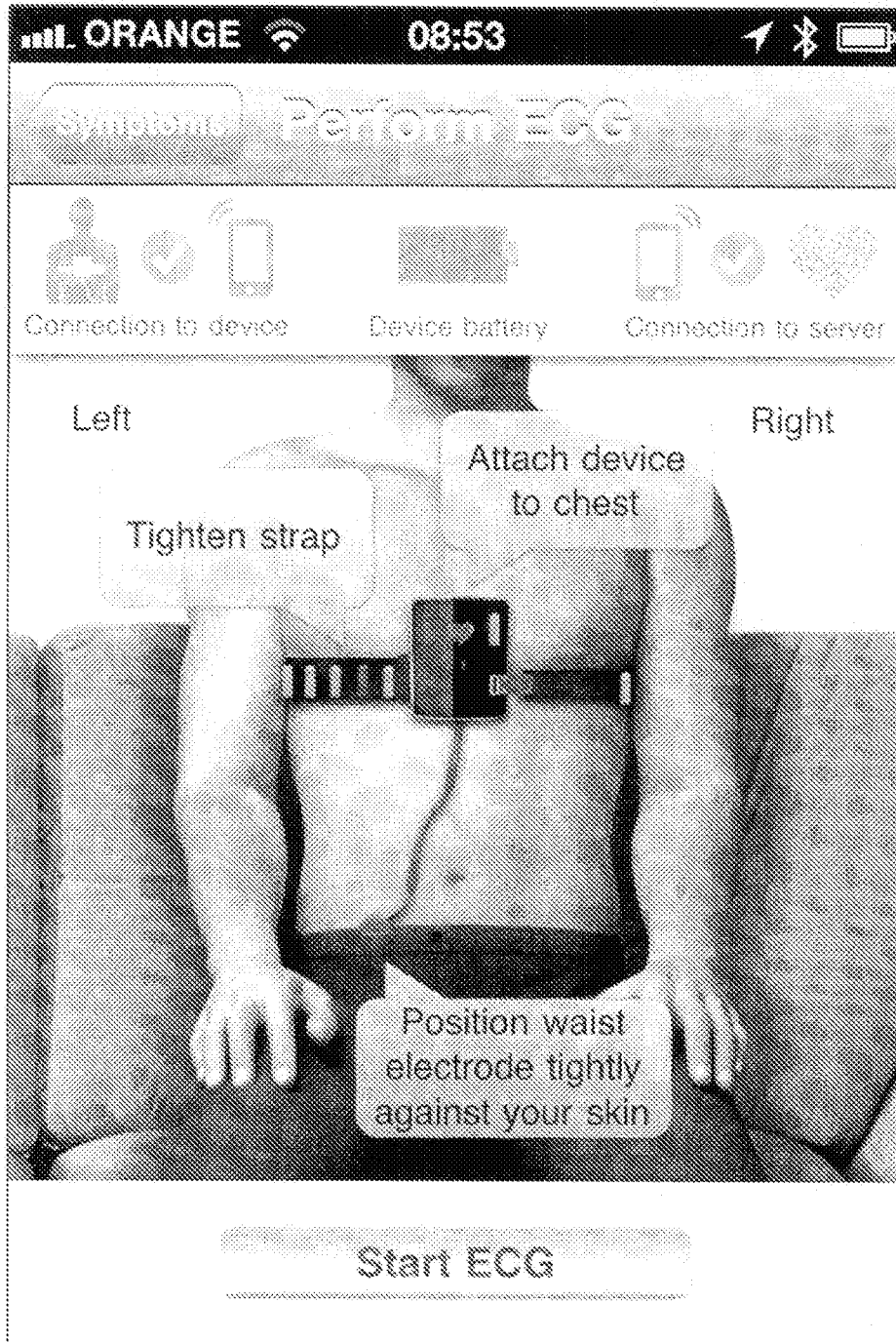


Fig. 8

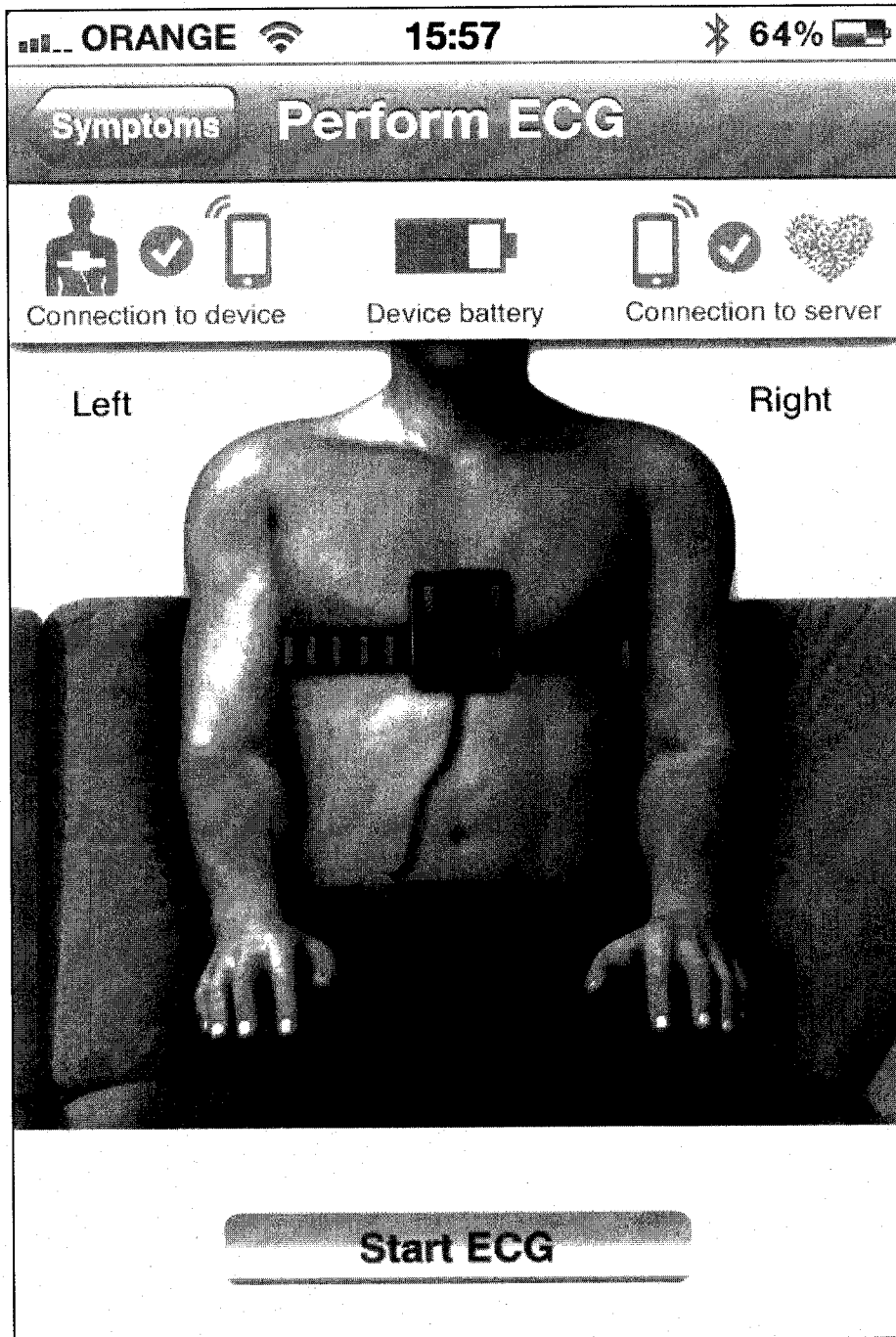


Fig. 9

View of recorded ECGs

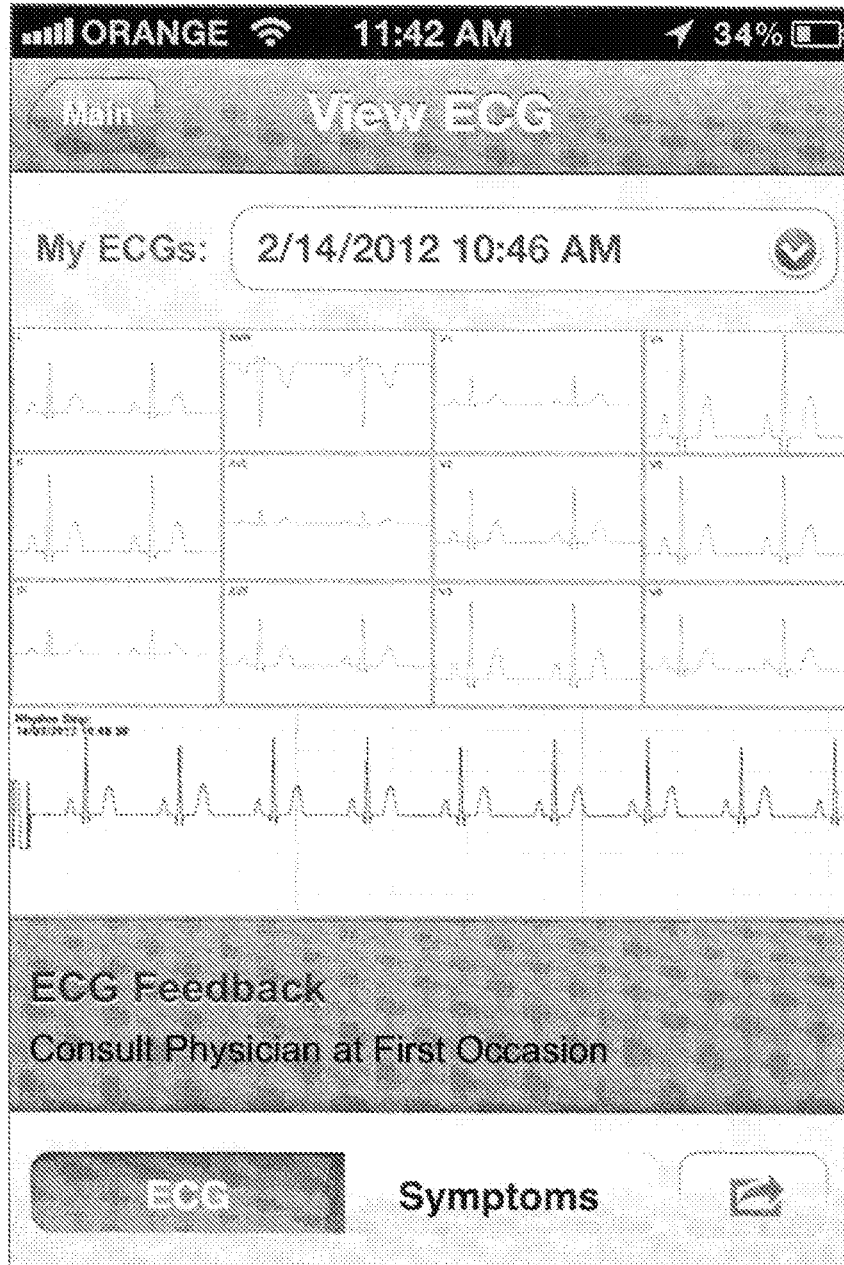


Fig. 10

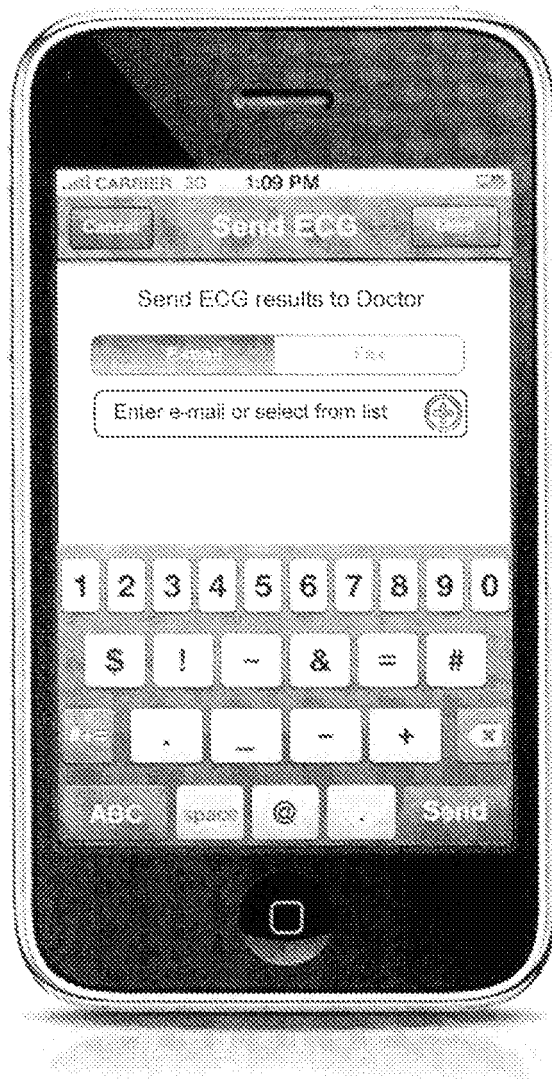


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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摘要(译)

一种用于获得标准12导联心电图和心律带的设备，包括：个人心电图设备，直接或通过电极带将九个皮肤监测电极电连接到该个人心电图设备，该设备具有至少6个心前电极阵列。在解剖学上为用户定位，两个皮带安装的肢体电极和一个悬空电极，以使部署在皮带上的皮肤监测电极与直接连接到个人ECG设备的皮肤监测电极结合，可以获取心律带和心电图的ECG数据。标准12导联ECG，其中ECG设备包括通信模块，用于通过移动设备将ECG数据传输到远程数据中心。