# Portable Health Monitoring Enabling Device

## RELATED APPLICATION

This application is related to commonly-owned International application no. PCT/SG2009/000358, the content of which is incorporated herein by reference.

## TECHNICAL FIELD

The present invention relates broadly to a portable health monitoring enabling device for enabling another electronic device to monitor the health of a subject, and to a method and a system thereof.

## BACKGROUND

Transtelephonic monitoring systems have been used to record electrophysiological signals arising from the beating heart by placing a handheld ECG recording device, usually with 3 pins at the base, over the chest and then transmitting the data by calling a phone land line to a remote receiving station. The ECG recording transmitted is then displayed on the monitor of the receiving station. This method of ECG transmission requires the use of a phone land line. One such system is described in U.S. Pat. No. 4,151,513.

Prior art Holter monitoring involves the placement of ECG electrodes over the chest of the subject and recording the electrophysiological signals of a beating heart and recording the signals in a ECG recording device attached to the electrodes by cables or wires. Prior art Holter monitoring systems have at least 3 ECG electrode pads and cables connected to a pocket device which records the data via tape or solid state hardware. Typically, the subject wears the Holter monitoring device continuously for 24 hours and the device is removed and the data is transferred to a computer with the software to display and analyse the ECG recordings. This method of monitoring is troublesome as the subject has to wear the electrodes and cables which are usually plastered down to the chest with adhesive tape. It is impractical to use this method of monitoring on a long term basis. One such system is described in US Patent Application Publication No. 2006/0025696.

International application no. PCT/SG2009/000358 discloses a mobile phone for recording ECG. However, a user may already have an existing mobile phone for communicating with others. Therefore, the user of the mobile phone for recording ECG may have to incur the costs associated with two mobile phone devices. The additional costs and the idea of possessing two mobile phone devices may be sufficient to dissuade a user from purchasing the mobile phone for recording ECG.

It is against this background that the present invention has been developed.

## SUMMARY

The present invention seeks to overcome, or at least ameliorate, one or more of the deficiencies of the prior art mentioned above, or to provide the consumer with a useful or commercial choice.

In accordance with a first aspect of the present invention, there is provided a portable health monitoring enabling device comprising:

a casing;

one or more sensor elements formed in or on the casing for measuring a physiological signal of a subject;

a signal processing module within the casing for processing and converting the measured physiological signal into physiological data;

a communication module within the casing for communicating, over a short range, with another electronic device capable of accessing a telecommunication network and having processing capabilities, wherein said communication module transmits said physiological data to said other electronic device for processing into health monitoring data to be sent over said communication network.

## BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

FIG. 1a shows a schematic diagram illustrating a front view of a portable health monitoring enabling device, according to an embodiment.

FIG. 1b shows a perspective view of the portable health monitoring enabling device according to the embodiment.

FIG. 2 shows a simplified functional block diagram of the portable health monitoring enabling device of FIG. 1.

FIG. 3 illustrates sensors on the portable health monitoring enabling device of FIG.1.

FIG. 4a to d illustrate four different configurations for using the portable health monitoring enabling device of FIG. 1 for recording ECGs according to an embodiment.

FIG. 5 shows a system and process diagram of a remote wireless health monitoring system.

FIG. 6 shows a schematic diagram illustrating a backend platform of the remote wireless health monitoring system of FIG. 5.

FIG. 7 illustrates a working screen capture on a workstation of the backend platform of FIG. 6.

FIG. 8 illustrates a customer screen capture for access to a health profile via the backend platform of FIG. 6.

**DETAILED DESCRIPTION**

In one aspect, the described example embodiments relate broadly to the application of a portable health monitoring enabling device for enabling another electronic device for monitoring the health of a subject. For example, the portable health monitoring enabling device and the other electronic device together constitute a portable health monitoring system for directly recording physiological data, process physiological data, displaying physiological data, storing physiological data and transmitting physiological data via a telecommunication network to a remote backend server.

Some portions of the description which follows are explicitly or implicitly presented in terms of algorithms and functional or symbolic representations of operations on data within a computer memory. These algorithmic descriptions and functional or symbolic representations are the means used by those skilled in the data processing arts to convey most effectively the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities, such as electrical, magnetic or optical signals capable of being stored, transferred, combined, compared, and otherwise manipulated.

Unless specifically stated otherwise, and as apparent from the following, it will be appreciated that throughout the present specification, discussions utilizing terms such as "scanning", "calculating", "determining", "generating", "initializing", "outputting", "displaying" or the like, refer to the action and processes of a computer system, or similar electronic device, that manipulates and transforms data represented as physical quantities within the computer system into other data similarly represented as physical quantities within the computer system or other information storage, transmission or display devices.

The present specification also discloses apparatus for performing the operations of the methods. Such apparatus may be specially constructed for the required purposes, or may comprise a general purpose computer or other device selectively activated or reconfigured by a computer program stored in the computer. The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose machines may be used with programs in accordance with the teachings herein. Alternatively, the construction of more specialized apparatus to perform the required method steps may be appropriate.

In addition, the present specification also implicitly discloses a computer program, in that it would be apparent to the person skilled in the art that the individual steps of the method described herein may be put into effect by computer code. The computer program is not intended to be limited to any particular programming language and implementation thereof. It will be appreciated that a variety of programming

languages and coding thereof may be used to implement the teachings of the disclosure contained herein. Moreover, the computer program is not intended to be limited to any particular control flow. There are many other variants of the computer program, which can use different control flows without departing from the spirit or scope of the invention.

Furthermore, one or more of the steps of the computer program may be performed in parallel rather than sequentially. Such a computer program may be stored on any computer readable medium. The computer readable medium may include storage devices such as magnetic or optical disks, memory chips, or other storage devices suitable for interfacing with a general purpose computer. The computer readable medium may also include a hard-wired medium such as exemplified in the Internet system, or wireless medium such as exemplified in the GSM mobile telephone system. The computer program when loaded and executed on such a general-purpose computer effectively results in an apparatus that implements the steps of the preferred method.

The invention may also be implemented as hardware modules. More particular, in the hardware sense, a module is a functional hardware unit designed for use with other components or modules. For example, a module may be implemented using discrete electronic components, or it can form a portion of an entire electronic circuit such as an Application Specific Integrated Circuit (ASIC). Numerous other possibilities exist. Those skilled in the art will appreciate that the system can also be implemented as a combination of hardware and software modules.

FIG 1a illustrates a front view of a portable health monitoring enabling device 100 according to an embodiment. A perspective view of the enabling device 100 is depicted in Figure 1b. The enabling device 100 is configured or adapted to measure a physiological or an electrophysiological signal of a subject. Preferably, the enabling device 100 is operable to measure (or derive), the ECG and the Heart Rate of the subject. However, it will be apparent to a person skilled in the art that the enabling device 100 is not limited to measuring such physiological signals and other types of physiological signals can be measured. In the example embodiment, the enabling device 100 is capable of recording, processing, storing and transmitting the physiological data to another electronic device.

The enabling device 100 has a casing or housing 101 as depicted in FIGs. 1a and 1b and one or more sensor elements, e.g., conductive sensor contacts 102, 104, 106, formed in or on the casing 101 for detecting or measuring the physiological signal of a subject. The enabling device 100 further includes an analog amplifier, an analog comparator and an analog to digital convertor (ADC), as will be described in more detail below. The enabling device 100 further includes a display 109 such as a LCD screen, one or more control buttons 111, a communication module 201, and a battery module 216. The control buttons 111 include one power button 111a for switching on/off the enabling device 100 and three navigation buttons.

FIG. 2 illustrates a simplified functional block diagram of the different modules included in the enabling device 100. As shown, the enabling device 100 has a processor module 212 such as a microcontroller module, a signal processing module 206 for processing the physiological signal, a display module 210 operable to display the physiological signal on the display 109, a battery module 216 for powering the enabling device 100, a short-range communication module or interface 201 for communicating with other electronic device(s), a memory module or storage medium 214 for storing data, and a movement detection module 218 for detecting movement of the subject. For example, the signal processing module 206 is a ECG signal processing (signal conditioning and filtering) module, the display module 210 is a LCD module, the communication module 201 may comprise a short-range wireless communication module 202 such as based on Bluetooth and/or Wi-Fi technologies and/or a wired communication module 204 such as a USB port. The processor module 212 is communicatively coupled to the above-mentioned modules and is operable to control the overall operation of the enabling device 100.

The signal processing module 206, under the control of the processor module 212, records analog physiological signals measured or detected by the sensors 102, 104, 106, amplifies and filters the physiological signals before converting the physiological signals into a digital format. The display module 210 is communicatively coupled to the display 109 such that the display module 210 is operable to receive the signals processed by the signal processing module 206 and display the signals on the display 109 of the enabling device 100. Preferably, the signals are displayed real-time as the signals are being recorded by the signal processing module 206. At the end of a

recording time period, which may be, but is not limited to, 45 seconds, the processor module 212 can be configured to prompt a user on the display 109 to cause the recorded physiological data to be transmitted to another electronic device, and from there to a backend server over a telecommunication network, or store the recorded physiological data in the memory module 214 of the enabling device 100. Preferably, the signal processing module 206 is shielded by an RF shielding cover (not shown).

For example, the processor module 212 is operable to convert the (filtered) physiological signals into a mark-up language-based data format, such as Extensible Markup Language (XML), for storage in the memory module 214 and subsequent transmission. The memory module 214 stores all the physiological data recorded and processed on the enabling device 100.

FIG. 3 illustrates the sensors 102, 104, 106 for the purpose of obtaining the physiological data such as ECG in analog signal format through contact of the sensors 102, 104, 106 surfaces with the user.

The sensors 102, 104, 106 are metallic in this example embodiment for potential difference measurements between different points of the body (in the case of ECG) when in contact with the user. The sensors 102, 104, 106 can be made from a variety of materials, including, but not limited to, gold, stainless steel, copper or other metals capable of enabling the detection and conduction of electro physiological signals from the sensor 102, 104, 106 surfaces to the signal processing module 206, and including compound structures such as stainless steel plated with gold in one example embodiment. In the example embodiment, the sensor 102 functions as the neutral lead, the sensor 104 as the negative lead and the sensor 106 as the positive lead. Together, when the three sensors 102, 104, 106 are in contact with the user in a variety of configurations, different types of signals can be recorded in analog form. In this embodiment, the enabling device 100 is capable of recording all the modified pre-cordial leads (in the V1 to V6 positions, noted as mV1 to mV6) and modified limb leads I-III based on different configurations of the three sensors 102, 104, 106 in contact with the user, as will be described in more detail below with reference to FIG 4.

As the voltage of the ECG signal is relatively low (in the range of millivolts), an amplification factor is applied to the signal obtained. Also, there is possible interference and noise from various factors such as environment and user handling, hence filtration of the signal is performed to remove or reduce the impact of these possible interferences on the integrity of the ECG signal.

In this example embodiment, to carry out the ECG recordings, the enabling device 100 is placed in four different ways in which the contact leads 102, 104, 106 come into contact with the right hand and/or left hand, and the limb or chest to obtain recordings of modified limb lead I, (mL I) modified limb lead II (mL II) and modified pre-cordial leads (mV1 to mV6 leads). FIGs 4a to 4d illustrate the four different configurations.

For the modified limb leads, the bi-polar limb leads I and II are measured in this example embodiment (using the configurations in FIGs 4a and 4b respectively), which according to Einthoven's Triangle, measures the electric potential between two points. Thus, for the bi-polar limb leads, there is no need for a neutral lead. However, holding the phone in one hand will typically mean that at least one finger of the hand contacts the neutral sensor (compare FIGs 4a and 4b), but no measurements are processed from that sensor for the bi-polar limb leads measurements. For the modified pre-cordial leads (using the configurations in FIGs 4d), the sensors are in contact with the chest, the right hand and the left hand of the user in this example embodiment. For the pre-cordial lead recordings the relevant mobile phone sensor was placed at the standard V1 to V6 positions on the chest.

The manner in which the enabling device 100 interacts with another electronic device 504 will now be described in more detail, referring to FIG. 5. The electronic device 504 can be any electronic device capable of executing a computer program and accessing a communication network. Preferably, the electronic device 504 is a mobile phone device such as a smartphone or a portable computing device such as a portable computer or a computer tablet.

In the embodiment, upon powering up the enabling device for the first time, the user 500 will be prompted to select the type of electronic device 504 to be enabled for

monitoring the health of a subject. As a result, the enabling device 100 and the electronic device 504 together constitute a portable or mobile health monitoring system 516. For example, in the case of an Android-based electronic device 504 being selected by the user 500, settings will be 'pushed' or transmitted from the enabling device 100 to the Android-based electronic device 504 to allow installation of non-Market applications. This will allow direct installation of an Android application onto the electronic device 504 from the memory module 314 in the form of an .apk file. Accordingly, the Android application is 'pushed' from the memory module 314 and installed in a memory module of the Android-based electronic device 504 executable by the electronic device 504 for providing health monitoring capability or functionality on the electronic device 504 through interaction with the enabling device 100.

Upon successful installation of the application in the electronic device 504, the user will be prompted to run or execute the application. On the first run of the application, the user will be prompted to pair the electronic device 504 with the enabling device 100. Once paired, the application is operable to control the electronic device 504 such that the electronic device 504 will automatically detect and communicatively connect with the enabling device 100 whenever the enabling device 100 is in range and powered on. The application will remain active in the background of the electronic device 504 as long as the user does not close it. As a result, the user 500 is able to record their physiological data in the peripheral health monitoring enabling device 100 and send the recorded physiological data to the paired electronic device 504 without having to manually initiate such functions. For example, the electronic device 504 can be in the pocket of the person or placed elsewhere as long as it is in range of the enabling device 100.

User/person 500 uses the enabling device 100 to record their ECG, subsequently sending the ECG data to a remote server monitoring system 508 via the integrated portable remote health monitoring system 516 through a wireless communications network 506 such as a telecommunication network (e.g., 3G or 4G) or any other type of wireless communications technology, e.g., Wi-Fi. Preferably, the monitoring system 508 operates at all times (i.e., 24 hours a day). At the monitoring system 508, qualified Technologists interpret the ECG and an appropriate response is sent back to the user 500 e.g. via SMS 510 or other messaging means to the paired electronic device 504. If

required, the ECG can be sent as an image file 512 such as JPEG format to any other electronic device, e.g., a mobile phone, 512 that is capable of receiving image files, for the purpose of remote consultation between the user 500 and a physician or doctor. It will be appreciated that upon receipt, the ECG image file can be viewed on the electronic device 512 using the standard viewing tools typically provided on electronic devices capable of receiving image files, including zoom-in, zoom-out and scrolling during zooming, thus enabling a physician or doctor to view relevant portions of the ECG, notwithstanding the size of the image file.

By way of example only, the functions of the Android application when executed by the electronic device 504 are summarised in Appendix A. It will be appreciated that the functions of the Android application are not limited to those described in Appendix A. Further, it would be apparent to the person skilled in the art that the functions described in Appendix A can be modified accordingly for various purposes.

It would be apparent to the person skilled in the art that although an Android-based electronic device has been described above, the electronic device 504 is not to be limited to any particular type of platform or operating system. For example, it will be appreciated that iOS-based electronic devices and other electronic devices based on other types of platform may also be used.

For iOS-based electronic devices, since all iOS applications have to be downloaded from the iTunes store, when iOS is selected upon first powering up the enabling device 100, the direct iTunes store link to the iOS application may be 'pushed' to the iOS-based electronic device 504, prompting the user to open the link to download and install the application from the iTunes store.

By way of example only, the functions of the iOS application when executed by the electronic device are summarised in Appendix B. Similarly, it will be appreciated that the functions of the iOS application are not limited to those described in Appendix B. Further, it would be apparent to the person skilled in the art that the functions described in Appendix B can be modified accordingly for various purposes.

Accordingly, through the above-described steps by way of example only, the enabling device 100 enables the paired electronic device 504 to monitor the health of a subject, in particular, the physiological signals of the subject in relation to ECG for example.

In addition to the sensor-manager integration of the enabling device 100 and the electronic device 504 as described above, there exists further integration at the data level in an embodiment. In particular, the processor module 212 of the enabling device 100 is configured to generate identification (ID) information and embed the ID information to the physiological data recorded, processed and stored on the enabling device 100. For example, the ID information may be generated based on user profile information stored in the enabling device 100. The embedded ID information will be cross-referenced and verified with an identification (ID) information belonging to the application installed on the electronic device 504. For example, the ID information may be a unique identification tag on the application. This is to ensure security and/or privacy of the data as the data is communicated between the enabling device 100 and the electronic device 504 of the integrated portable remote health monitoring system 516.

By way of example, the case where the ID information generated by the processor module 212 of the enabling device 100 is based on a user profile will now be described. The enabling device 100 is operable to generate a user interface on the display 109 under the control of an application installed in the memory module 214 of the enabling device 100 when executed by the processor module 212. Through the user interface on the display 109, the user 500 is able to create, edit and/or select a customized user profile by using the navigation buttons 111b, 111c, 111d. However, it will be apparent to the person skilled in the art that the display 109 can be a touch screen and thus less or no navigation buttons may be required Based on the user profile, the processor module 212 is operable to generate an ID information and embed the generated ID information into the recorded physiological data. For example, the ID information may be taken directly from the user profile and embedded as a tag in the XML data. When the physiological data having the embedded ID information is transmitted to the paired electronic device 504, there is a second level of security verification where a unique identification tag based on the account user name is cross-referenced with the embedded ID information in the recorded physiological data, before

the data is transmitted from the application to the remote server 508. That is, the first level of security tags data with the other profile ID, and the second level of security cross-references the user profile ID in the physiological data to the same profile ID tag on the paired mobile device 504. In the event that the embedded ID information in the data is unable to be cross-referenced to the unique identification tag on the driver application, the user 500 will be prompted with an error message and the recorded physiological data will not be transmitted to the remote server 508.

The purpose of this approach is to ensure that physiological data of an individual remains unique and is not sent out via a different individual's electronic device, which may result in falsification of physiological data on the remote server end. This will enable the enabling device 100 to be used by more than one user, yet maintaining the security, confidentiality and integrity of each individual's physiological data.

FIG. 6 shows a schematic diagram illustrating a backend platform 600 at the monitoring system 508 (FIG. 5) consisting of a local intranet server section 602 which hosts all personal information of the users, and an internet server section 604 which hosts all medical information of the users. When the user registers for a new user account, all the personal information such as name, age, gender, telephone number, address, etc. will be transferred and stored on the local intranet server 608, whereas all the medical information such as medical history, drug allergies, etc. will be sent and stored on the Internet server 610. The two server sections 602, 604 are segregated physically for security reasons and the only common identifier between both databases in the two servers is the user ID 606 generated by the system 600 in this example embodiment. This arrangement can preferably ensure the confidentiality of the medical information hosted on the Internet server 610 while providing the convenience and flexibility of a virtual health repository accessible from any location via the Internet, as the user ID 606 does not contain any indication of the actual identity of the user.

The local intranet server section 602 is staffed by a group of Customer Service Operators at workstations e.g. 612 who will answer to users' queries when they call in to the Service Centre hotline number. The operators will serve all requests and queries pertaining to the personal information of the users as they do not have access to any medical information of the users. The Internet server section 610 is staffed by a group of

Technologists at workstation e.g. 614 who are qualified to interpret ECGs that are sent by users from their mobile or portable health monitoring system 516 (comprising the enabling device 100 paired/integrated with an electronic device 504) to the Internet server 610, preferably, 24 hours a day, 7 days a week, in this example embodiment.

When the Internet server 610 receives the XML file transmitted by the user 500 using the integrated portable remote health monitoring system 516 formed by pairing the enabling device 100 and an electronic device 504, the system 600 identifies the user through the user ID 606 that is embedded in the XML data string. The XML file is then converted into an image file such as JPEG format, for easy viewing and interpretation by the Technologists at the workstations e.g. 614. In one example embodiment, the User ID is programmable via the programs and or applications designed to integrate the enabling device 100 and an electronic device 504. During initial user setup, the user 500 inputs their mobile number or any other number on which the user wishes to receive feedback from the system 600 via the programs and or applications designed to integrate electronic devices with the enabling device 100. Once configured, the backend platform 600 will then be able to 'recognise' the user by matching the User ID and mobile number stored in the ECG XML data stream with that stored on the backend platform 600 database. The User ID and mobile number are thus created in the database during the Registration process where the user fills in their personal particulars and medical history, if any.

FIG 7 illustrates a working screen capture 700 on a workstation (e.g. 610, FIG 6) for the Technologists. A baseline ECG 702 is displayed on the top half of the screen 700 right above the current ECG 704 that is displayed on the bottom half of the screen. In this example embodiment, the ECG can be viewed on the working screen capture 700 in the standard ECG grid format of speed of 25mm/s and amplitude scale of 10mm for 1mV.

The baseline ECG 702 is the first ECG that was taken by the user upon registration of a new user account with the service centre and is the basis that future ECGs will be compared against for irregularities or deviations. This arrangement advantageously allows for comparison of the current ECG 704 with the baseline ECG 702 to distinguish any irregularities or deviations, as well as careful examination of the

current ECG 704, made easier by the static image format (e.g. picture) such as JPEG in this example embodiment as compared to a motion image format (e.g. video) such as MPEG.

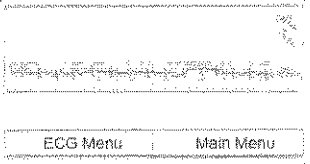
FIG 8 illustrates a customer screen capture for access to a health profile 800 of the user after logging into their account online on the Internet. Other than the ECG log 802, health parameters such as Blood Glucose 804, Blood Pressure 806 and Cholesterol 808 are tabulated and displayed as graph trends based on user inputs transmitted from the enabling device 100. This allows the user to track and monitor their health parameters and health profile conveniently over the Internet, with graphical representations of the data for easy understanding and viewing over a period of time. Another use of this is for physicians or doctors to monitor the trends in the user's health parameters remotely (upon authorization by the user) and dispense appropriate advice.

As mentioned above, in the example embodiment, the health profile 800 accessible remotely through the internet server 604 (FIG. 6) does not contain any personal information of the users, but rather is associated (only) with the current user ID 810, preferably ensuring the confidentiality of the medical information while providing the convenience and flexibility of a virtual health repository accessible from any location via the internet. In other words, even if an unauthorised user such as a person performing a hacking attack on the system gains access to the health profile 800, there is no data accessible to that person that identifies the true identity and other personal information of the actual person "behind" the health profile 800. Such personal information is only kept at the intranet server 602.

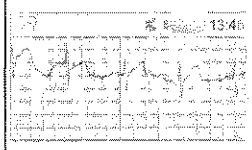
It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

# Appendix A

Specific requirements for EPI Mini Android App

| S/N | Function | Activation | Screen | Remarks |
|---|---|---|---|---|
| 1 | Launch App | Tap on EPI Mini Android App in phone | Upon launch, check for BT pairing OK and connection to server OK, status to be shown on Home Screen | |
| | | | If BT not active, prompt user to activate BT function | |
| | | | If BT active but no device found, prompt user | |
| | | | If server connection not ok, prompt user to check account details or connection | |
| 2 | ECG Mode | Tap on ECG icon on Home Screen | Display table of ECGs stored in SD storage, with Date/Time, Status and View columns | |
| 2.1 | View ECG | Tap on individual ECG icons in table | Screen displays ECG in landscape mode. Tapping on the screen brings up Zoom In/Out buttons on top right corner and ECG Menu and Main Menu buttons on bottom of screen |   |
| | | | Default zoom is 30 seconds (whole strip) | |
| | | | Steps: 30sec (150大格, default), 12sec (60大格), 6sec (30大格), 3sec (15大格), 1.5sec (7.5大格) | |
| | | | To show scrollbar when zoomed in to indicate relative viewing position on entire ECG strip | |
| 2.2 | Delete ECG | Tap on Menu and select Delete ECG | Additional column with checkboxes will appear in table of ECGs. Topmost checkbox will serve purpose of Select All. Delete ECG button will appear on screen in this mode. Once selection is done, click on Delete ECG. Pop up will appear to ask user to confirm delete (YES/NO). After Delete, to return to ECG Mode screen. | |
| 3 | Send Data | Tap on Send Data button on Home Screen | Pop up will appear if there are pending ECGs on phone to be sent to server. It will show progress bar of 100% with ?/? to show progress of sending. Upon send success to indicate ? ECGs sent. | |
| 3.1 | No pending ECGs | | Pop up to prompt user that no pending ECGs | |
| 3.2 | Send Failed | | Pop up to prompt user that send failed and please try again | |
| 4 | Settings | Tap on Menu and select Settings | To display Settings Mode | |
| 4.1 | Account | | | |
| 4.1.1 | User ID | Tap on User ID dropdown | Allow user to input/change Customer ID | |
| | | | On first install/launch, prompt user to input ID and password and mobile number. | Required for ECG sending |
| 4.1.2 | Password | Tap on Password dropdown | Allow user to input/change password for server login (for myHealth portal) | Required only for myHealth portal access |
| 4.1.3 | Mobile Number | Tap on Mobile Number | To auto-detect mobile no. if possible, otherwise to prompt user to input on first install/launch | Required for ECG sending |
| 4.2 | Device | | | |
| 4.2.1 | Pair Device | Tap on Pair Device dropdown | Displays the EPI Mini device that is currently paired with the phone. | |
| 4.2.1.1 | Scan for Devices | Tap on Scan for Devices | As per existing function in prototype app | |
| 4.3 | Sound Settings | | | |
| 4.3.1 | Sound On/Off | Checkbox to toggle sound On/Off | | |
| 4.4 | Country Setting | Tap on Country dropdown | Select Country | Or auto-detect from Customer ID or mobile number? |
| 4.5 | Language Setting | Tap on Language Setting | Display languages available for selected country | |
| 5 | Help | Tap on Menu and select Help | Displays list of Help Topics | |
| 6 | About | Tap on Menu and select About | Displays information on EPI Android App version and copyright/credits | |

# Appendix B

| S/N | Function | Activation | Screen | Remarks |
|---|---|---|---|---|
| 1 | Power On | Press & hold Power On/Off button for 1(TBD) seconds when phone is off | Upon power on, EPI Logo splash screen ~~with firmware version on bottom right~~ | [redacted] |
| | 1.1 | If single device found | show 'Searching Device...', and then show 'Connected to Device A' as connect successfully | |
| | 1.2 | If more than 1 device found | show 'Select Device' with options on screen. Select using up/down buttons and confirm using Heart Button. Show 'Connected to Device A' upon successful connection | |
| | 1.3 | If no device found | show 'No device found' | |
| | 1.4 | Connect failed | For 1.1 and 1.2, if connect failed, show 'Connection Failed. Please try again.' | |
| 2 | Power Off | Press & hold Power On/Off button for 1.5(TBD) seconds when phone is on | Upon power off, screen to display 'Power Off' followed by EPI Logo splash screen | |
| 3 | Record ECG | Select 'Record ECG' function on home screen | Upon selecting 'Record ECG', to show 'Activating ECG', followed by 'Starting ECG in 3, 2, 1 (countdown)'. During ECG recording, to show ~~a moving graphic (either heart or ECG graphic)~~ heart shape together with a 30 second countdown timer on top left corner of screen. Real-time ECG waveform to be displayed on screen upon start of recording. | show warning message 'memory is full!' before activating ECG recording  |
| | | | ~~Upon completion, show 'Send Now?' 'OK - Yes', 'On/Off - No'.~~ Upon Completion to show new screen with 2 selection choices: Send Now and Send Later. User can use Up/Down buttons to navigate between both choices and Heart Button to confirm. | Upon completion, to have 'sound alert' (beep) |
| | | | | |
| | 3.1 | Save | Saving' followed by 'Saved', then showing the file in ECG Manager on screen | |
| | 3.2 | Send | Sending...', and show 'send success' or 'send failed' | When 'Send' selected, ECG automatically saved. For Send Failed message, include 'Check Bluetooth Connection with phone' |
| | 3.2.1 | If single device found | Sending...' followed by 'Send Success' or 'Send Failed' | |
| | 3.2.2 | If more than 1 device found | Select device to send to. Upon selection, 'Sending...' followed by 'Send Success or 'Send Failed' | |
| | 3.3.3 | If no device found | No Device Found' | |
| 4 | ECG Manager | Select 'ECG Manager' function on home screen | Send ECG' and 'Delete ECG' | |
| | 4.1 | Send All ECG | Sending ?/??...' (to indicate progress, e.g. 3/10) | |
| | 4.1+ | Send Single ECG | Sending...', and show 'Send Success' or 'Send Failed | For Send Failed message, include 'Check Bluetooth Connection with phone' |
| | 4.1.1 | If single device found | Sending...' followed by 'Send Success' or 'Send Failed' | |
| | 4.1.2 | If more than 1 device found | Select device to send to. Upon selection, 'Sending...' followed by 'Send Success or 'Send Failed' | |
| | 4.1.3 | If no device found | No Device Found' | |
| | 4.2 | Delete ECG | Delete single' or 'Delete all' | |
| | 4.2.1 | Delete Single | Select ECG file on screen | |
| | | | Click 'OK' to delete | |
| | | | ~~Prompt 'OK to confirm delete' 'On/Off to cancel'~~ To show new screen with Confirm Delete then Yes and No? and Cancel. User can use Up/Down buttons to navigate between both choices and Heart Button to confirm. | Confirm Delete?<br>Yes<br>No |
| | 4.2.2 | Delete All | ~~Prompt 'OK to confirm delete' 'On/Off to cancel'~~ To show new screen with Confirm Delete then Yes and No? and Cancel. User can use Up/Down buttons to navigate between both choices and Heart Button to confirm. | Confirm Delete?<br>Yes<br>No |

| | | | | |
|---|---|---|---|---|
| 5 | Settings | Select 'Settings' on Home screen | Date/Time', 'Language' and 'User Settings' | |
| | 5.1 | Date/Time | Select 'Date/Time' to set date | Date to be in YYYY/MM/DD format |
| | | | Use directional buttons to change numbers and OK to proceed to next field. ~~At end, prompt 'Save?'~~ | |
| | 5.2 | Language | Select 'Language' to set language | > English<br>> Traditional Chinese<br>> Simplified Chinese<br>> Bahasa<br>> French<br>... |
| | | | Choose from list of available languages and press 'OK' to confirm | |
| | 5.3 | User Settings | For multi-user and single user and user profiles. | |
| | 5.3.1 | Create New User | | max. 5 users with 3 characters |
| | 5.3.2 | Select User | Select user from list of 5 using up/down keys and Heart Button | |
| | 5.4 | System Information | | |
| | 5.4.1 | Firmware Version | To display current firmware version | |
| | 5.4.2 | Device Name | To display device name ~~and default PIN~~ for BT pairing | |

| | | | |
|---|---|---|---|
| | USB charger behavior | Interrupt and disable all device functions, and change to USB mode | |
| | | Show 'charging' icon at battery location on screen as device turn-on | |
| | | Show 'charging' icon on screen for 5 seconrds and then display off as device turn-off | |
| | Battery behavior | Show red battery icon as low battery | Single beep for low battery |
| | | Show 'low-battery turn-off' (TBD) | Triple beep for low battery shutdown |

Remarks:

1 Replace all mention of 'OK' button with 'Heart Button'

2 Whenever not specified, Power On/Off button will be designated as the 'back' button to exit current menu

**CLAIMS:**

1. A portable health monitoring enabling device comprising:

a casing;

one or more sensor elements formed in or on the casing for measuring a physiological signal of a subject;

a signal processing module within the casing for processing and converting the measured physiological signal into physiological data; and

a communication module within the casing for communicating, over a short range, with another electronic device capable of accessing a telecommunication network and having processing capabilities, wherein said communication module transmits said physiological data to said other electronic device for processing into health monitoring data to be sent over said communication network.