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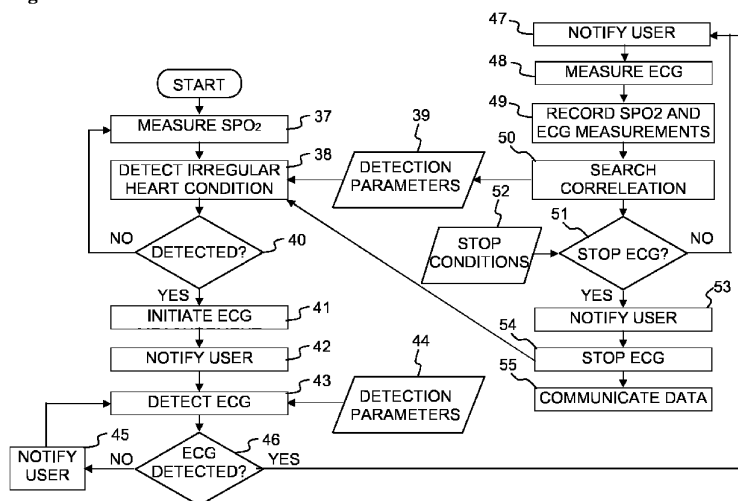
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(54) Title: PULSE OXIMETRY MEASUREMENT TRIGGERING ECG MEASUREMENT

Fig. 7



(57) Abstract: A method and a system for triggering the measurement of electrocardiogram (ECG) signal of a user. The system includes a SpO<sub>2</sub> measuring unit and an ECG measuring unit both embedded in a wrist-mounted device worn by the user. The method including the steps of: continuously measuring SpO<sub>2</sub> at the wrist of the user, detecting an irregular heart condition from the SpO<sub>2</sub> measurement, notifying the user to perform an ECG measurement, and initiating the ECG measurement at least partially at the wrist.

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## **PULSE OXIMETRY MEASUREMENT TRIGGERING ECG MEASUREMENT**

### **Cross-Reference to Related Applications**

This application claims the priority benefit of U.S. Provisional Patent Application No. 61473821 filed April 11, 2011, which is incorporated herein by reference.

### **Field of the Invention**

The present invention relates to systems and methods for patient monitoring and, more particularly but not exclusively, to systems and methods for monitoring heart-related events using electrocardiogram (ECG).

### **Background of the Invention**

Various heart diseases require the monitoring of events associated with electrical activity of the heart. The electrical activity is typically monitored by measuring an electrocardiogram (ECG). Some heart diseases are reflected in permanent irregularities of the ECG signal. Other heart diseases are reflected in transient, very short-time, irregularities of the ECG signal. Some heart diseases are reflected in events of irregular ECG signal.

Measuring ECG typically requires connecting the patient to an ECG measuring device via a plurality of wires connected to the patient in predefined places of the body. If the heart-related event is short enough the patient does not have the time to find an ECG device, to properly wire the device to the body and then take the ECG measurement.

One common solution is a telemetry ECG device that is wired to the patient and transmits the ECG signal to a near-by telemetry station. Such devices are used in hospitals where it is important to monitor the patients at all time and also enable them mobility within the hospital ward. However, this solution has the disadvantage of the communication range of the ECG monitoring device.

Another common solution is a Holter device, which is practically a small ECG device connected to the patient for typically 24 hours, recording the ECG signal. Hopefully, the heart-related event occurs during the recording time. The Holter does not limit the mobility range of the patient but has a time limit of its operation. For events that

are not sufficiently frequent this solution does not work. Also important and highly disadvantageous is the Holter device uses electric contacts at the end of electric cables. Thus, the patient has to be constantly wired to the Holter device.

All such solutions require uncomfortable fixed wiring of the patient to the ECG device at all time. Solutions require uncomfortable fixed wiring are therefore inappropriate for monitoring infrequent events of irregular ECG. There is thus a widely recognized need for, and it would be highly advantageous to have, a method and a system for measuring the ECG signal associated with an intermittent irregular heart-related event, devoid of the above limitations.

The following patents and patent applications are believed to represent the most relevant prior art: US patents 5,176,137, 7,598,878, and 7650176; US patent applications 20020095092, 20030229276, 20070038050, 20090247848, and 20090326356; and PCT applications WO2001017420, and WO2009074985.

### **Summary of the Invention**

According to one aspect of the present invention there is provided a method for triggering measurement of electrocardiogram (ECG) signal of a subject, the method including the steps of: continuously measuring SpO<sub>2</sub> at least one of a wrist and a finger of the subject, detecting an irregular heart condition from the SpO<sub>2</sub> measurement, notifying the subject to perform an ECG measurement, and initiating ECG measurement at least partially at the wrist.

According to another aspect of the present invention there is provided a method for triggering ECG measurement where the step of notifying the subject to perform an ECG measurement includes at least one of the acts of: notifying the subject to perform an ECG measurement repeatedly until the ECG measurement detects an ECG signal, stopping the notification to the subject to perform an ECG measurement when the ECG measurement detects an ECG signal, notifying the subject when the ECG signal is first detected, notifying the subject that the ECG signal is being detected, notifying the subject as long as the ECG signal is detected, and notifying the subject that the ECG measurement has stopped.

According to still another aspect of the present invention there is provided a method for triggering ECG measurement additionally including the steps of: performing

the SpO2 measurement while performing the ECG measurement, identifying a correlation between the SpO2 measurement and the ECG measurement, and using the correlation in the step of detecting an irregular heart condition from the SpO2 measurement.

Yet according to another aspect of the present invention there is provided a method for triggering ECG measurement where the correlation is particular to the subject.

Also according to another aspect of the present invention there is provided a method for triggering ECG measurement where the ECG measurement is stopped upon detecting at least one of the conditions of: the irregular heart condition stopped, heart condition returned to normal, a predefined period elapsed, and a predefined number of heart beats counted.

Further according to another aspect of the present invention there is provided a method for triggering ECG measurement where the SpO2 measurement includes using reflective SpO2 measurement.

Yet further according to another aspect of the present invention there is provided a method for triggering ECG measurement where the ECG measurement additionally includes the steps of: providing at least two separate conductive areas configured to measure electrical activity of the subject, performing at least one of the steps of: contacting a first conductive area to at least a portion of the wrist, and a second conductive area to a finger of a second hand of the subject, contacting a first conductive area to at least a portion of the wrist, and a second and a third conductive areas to two fingers of a second hand of the subject, and contacting a first and a second conductive areas to at least a portion of the first hand and a third conductive area to a second hand of the subject; extracting an ECG signal from the conductive areas by using one conductive area as a reference and amplifying the differential voltage between at least two other conductive areas; and continuously converting the at least one measurement to form medical information.

Still further according to another aspect of the present invention there is provided a method for triggering ECG measurement where the ECG measurement additionally includes the step of: communicating at least one of the SpO2 measurement, the ECG measurement, and the medical information to at least one of a gateway and a remote server.

According to yet another aspect of the present invention there is provided a wrist-mounted physiological parameters measuring device including: an SpO2 measuring unit attached to a wrist of a subject the SpO2 measuring unit being operative to continuously measure SpO2 at the wrist of the subject, an ECG measuring unit attached to the wrist of the subject for measuring ECG signal at least partially at the wrist, and a processor operative to control both the SpO2 measuring and the ECG measuring unit, where the processor is operative to detect an irregular heart condition from the SpO2 measurement, to notify the subject to perform an ECG measurement upon detecting the irregular heart condition the, and to initiate the ECG measurement.

According to still another aspect of the present invention there is provided a wrist-mounted physiological parameters measuring device where the processor is additionally configured to perform at least one of the procedures selected from the group including of: a procedure for notifying the subject to perform an ECG measurement repeatedly until the ECG measurement detects an ECG signal, a procedure for stopping the notification to the subject to perform an ECG measurement when the ECG measurement detects an ECG signal, a procedure for notifying the subject when the ECG signal is first detected, a procedure for notifying the subject that the ECG signal is being detected, a procedure for notifying the subject as long as the ECG signal is detected, and a procedure for notifying the subject that the ECG measurement has stopped.

Further according to another aspect of the present invention there is provided a wrist-mounted physiological parameters measuring device where the processor is additionally configured to perform at least one of the procedures selected from the group including of: a procedure performing the SpO2 measurement while performing the ECG measurement, a procedure for identifying a correlation between the SpO2 measurement and the ECG measurement, and a procedure for detecting the irregular heart condition from the SpO2 measurement using the correlation.

Still further according to another aspect of the present invention there is provided a wrist-mounted physiological parameters measuring device where the correlation is particular to the subject.

Yet further according to another aspect of the present invention there is provided a wrist-mounted physiological parameters measuring device where the processor is additionally configured to stop the ECG measurement upon detecting at least one of the

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