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

(11) EP 2 886 044 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.08.2019 Bulletin 2019/35

(51) Int Cl.:
A61B 5/00 *(2006.01)* ***A61B 5/0428*** *(2006.01)*

(21) Application number: **14156018.5**

(22) Date of filing: **20.02.2014**

(54) **System and a method for acquisition of ECG signals with motion artifact reduction.**

System und Verfahren zur Erfassung von EKG Signalen mit Bewegungsartefaktreduzierung

Système et procédé pour l'acquisition de signaux ECG avec réduction d'artéfacts de mouvement

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

(30) Priority: **23.12.2013 EP 13199276**

(43) Date of publication of application:
24.06.2015 Bulletin 2015/26

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Printed by Jouve, 75001 PARIS (FR)

Description

Technical Field

[0001] The present invention relates generally to the field of ECG signal acquisition systems and more specifically to a system and a method for acquisition of ECG signals with motion artifact reduction using digital adaptive filtering.

Background

[0002] Ambulatory monitoring of biopotential signals, such as electrocardiogram (ECG), electroencephalogram (EEG), electromyogram (EMG), etc., is a highly relevant topic in personal healthcare. A key technical challenge in such application environments is overcoming motion artifacts that significantly affect the recorded biopotential signals. An approach to reduce motion artifacts is by using digital adaptive filtering. For example, a known biomedical acquisition system with motion artifact reduction is disclosed in EP 2 591 720 A1, which uses digital adaptive filtering (e.g. a LMS filter), implemented in a digital domain, to calculate a motion artifact estimate which is then fed back to the analogue domain and subtracted from the measured ECG before final amplification. Another known technique for motion artifact removal using a two-stage cascade LMS adptive filter is disclosed in the document "Motion Artifact Removal using Cascade Adaptive Filtering for Ambulatory ECG Monitoring System", by Hyejung Kim et al., Biomedical Circuits and Systems Conference (BioCAS), November 2012 IEEE, Hsinchu, Taiwan.

Summary

[0003] According to one aspect of the present invention, a new ECG signal acquisition system according to claim 1 is provided with improved motion artifact reduction. According to another aspects the invention is advantageous for ambulatory and/or low power ECG monitoring applications.

[0004] According to the invention there is provided an ECG signal acquisition system comprising an analogue readout unit configured to receive an analogue ECG signal and to extract, from that received analogue ECG signal, an analogue measured ECG signal and an analogue electrode-tissue impedance signal, an ADC unit configured to provide a digital version of the analogue measured ECG signal and the analogue electrode-tissue impedance signal, a reference signal processing unit configured to convert the electrode-tissue impedance signal into a new reference signal, wherein the reference signal processing unit is configured to perform a polarity calculation based on the correlation between the measured ECG signal and the electrode-tissue impedance signal and wherein the reference signal processing unit generates a new reference signal that is the same as the electrode-tissue impedance signal if the polarity information has a first value indicating that the electrode-tissue impedance signal has the same polarity as the measured ECG signal, or generates a new reference signal that has a polarity opposite to the polarity of the electrode-tissue impedance signal if the polarity information has a second value indicating that the electrode-tissue impedance signal has an opposite polarity than the measured ECG signal and a digital filter unit configured to calculate a digital motion artifact estimate (MA) based on the digital version of the measured ECG signal and the new reference signal provided by the reference signal processing unit. The received analogue ECG signal may be acquired, for example, from at least one electrode attached to a living being's body.

[0005] According to an exemplary embodiment, the correlation between the measured ECG signal and the electrode-tissue impedance signal may be estimated by calculating the correlation between the motion artifact estimate signal and the electrode-tissue impedance signal.

[0006] According to an exemplary embodiment, the new reference signal with a polarity opposite to the polarity of the electrode tissue impedance signal also considers a reference offset.

[0007] According to an exemplary embodiment, the reference signal processing unit may be implemented in an analogue domain part or digital domain part of the system.

[0008] According to an exemplary embodiment, the digital filter unit may implement or runs a digital adaptive filter, such as, for example an LMS filter.

[0009] There is also provided and electronic device comprising a ECG signal acquisition system according to any of the embodiments herein described.

[0010] According to the invention there is also provided a method for acquisition of biopotential signals, comprising: in an analogue readout unit, extracting, from an analogue ECG signal, an analogue measured ECG signal and an analogue electrode tissue impedance signal, in a reference signal processing unit, converting the electrode-tissue impedance signal into a new reference signal based on the correlation between the measured ECG signal and the electrode-tissue impedance signal, wherein a polarity is calculated based on the correlation between the measured ECG signal and the electrode-tissue impedance signal and wherein a new reference signal is generated that is the same as the electrode-tissue impedance signal if the polarity information has a first value indicating that the electrode-tissue impedance signal has the same polarity as the measured ECG signal, or a new reference signal is generated that has a polarity opposite to the polarity of the electrode-tissue impedance signal if the polarity information has a second value indicating that the electrode-tissue impedance signal has an opposite polarity than the measured ECG signal and in a digital filter unit, calculating a digital motion artifact estimate based on the digital version of the measured ECG signal and the new reference signal.

[0011] Certain objects and advantages of various new and inventive aspects have been described above. It is to be understood that not necessarily all such objects or advantages may be achieved in accordance with any particular embodiment of the present invention. Those skilled in the art will recognize that the solution of the present invention may be embodied or carried out in a manner that achieves or optimizes one advantage or group of advantages without necessarily achieving other objects or advantages.

Brief description of the drawings

[0012] The above and other aspects of the system and method for acquisition of ECG signals according to the present invention will be shown and explained with reference to the non-restrictive example embodiments described hereinafter.

Figure 1 shows a first exemplary block diagram of an ECG signal acquisition system according to an embodiment of the invention.

Figure 2 shows a second exemplary block diagram of an ECG signal acquisition system according to an embodiment of the invention.

Figure 3 shows a flow diagram of a method for acquisition of ECG signals according to an embodiment of the invention.

Figure 4 illustrates exemplary graphs of signals generated in an ECG signal acquisition system according to an embodiment of the invention.

Detailed description

[0013] In the following, in the description of exemplary embodiments, various features may be grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This is however not to be interpreted as the invention requiring more features than the ones expressly recited in the main claim. Furthermore, combinations of features of different embodiments are meant to be within the scope of the invention, as would be clearly understood by those skilled in the art. Additionally, in other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure the conciseness of the description.

[0014] **Figure 1** shows a first exemplary block diagram of an ECG signal acquisition system **100** according to an embodiment of the invention. The system comprises an analogue domain part **50** configured to receive at least one analogue ECG signal **BS1**, which may be acquired, for example, from at least one sensor electrode attached to a living being body, and comprises an analogue readout unit **10** which extracts at least one analogue measured ECG signal **BS2** and at least one analogue electrode-tissue impedance signal **REF1**. The analogue measured ECG signal **BS2** and the analogue electrode-tissue impedance signal **REF1** are then provided to an analogue-to-digital converter (ADC) unit **20**, which comprises one or more ADCs configured to convert those signals into digital versions which are then handled in the digital domain part **60** of the system. A reference signal processing unit **30** receives the digital versions of the measured ECG signal **BS2** and the electrode-tissue impedance signal **REF1** and is configured to calculate a correlation between both signals and generate a new reference signal **REF2** based on the value of that correlation. Then, a digital filter unit **40** receives the measured ECG signal **BS2** and the new reference signal **REF2** and calculates an estimated noise or motion artifact estimate **MA**, which is used to reduce the motion artifact from the measured ECG signal.

[0015] According to an exemplary embodiment, the reference signal processing unit **30**, based on the correlation value between the measured ECG signal **BS2** and the electrode-tissue impedance signal **REF1**, checks the polarity between both signals and adapts the electrode-tissue impedance signal **REF1** based on such polarity value. If the polarity information has a first value, indicating that the electrode-tissue impedance signal **REF1** has the same polarity as the measured ECG signal **BS2**, then the reference signal processing unit **30** provides a signal **REF2** that is the same as electrode-tissue impedance signal **REF1** to the digital filter unit **40**; if the polarity information has a second value, indicating that the electrode-tissue impedance signal **REF1** has an opposite polarity than the measured ECG signal **BS2**, then the reference signal processing unit **30** provides a signal **REF2** that has polarity opposite to the polarity of the electrode-tissue impedance signal **REF1**.

[0016] According to an exemplary embodiment, the correlation value between the measured ECG signal **BS2** and the electrode-tissue impedance signal **REF1** is calculated continuously. According to an exemplary embodiment, the correlation value varies between a maximum value, e.g. +1, in the case of a perfect positive (increasing) linear relationship (correlation) and a minimum value, e.g. -1, in case of a perfect decreasing (negative) linear relationship (anti-correlation), depending on the degree of linear dependence between the signals. The polarity calculation is then performed by comparing the calculated correlation value with a certain threshold value, which can be a certain predefined value or dynamically calculated. According to an exemplary embodiment, in case the calculated correlation value is equal to and/or greater than a certain threshold value, the polarity value is given a first value, e.g. 0, and in case the calculated correlation value is equal to and/or lower than a certain threshold value, the polarity value is given a second value, e.g. 1. According to an exemplary embodiment, once the polarity value is updated, it is maintained for a certain period of time in order to avoid oscillation.

[0017] According to an exemplary embodiment, the reference signal processing unit **30** generates a new reference signal **REF2**, which is an adaptation of the received electrode-tissue impedance signal **REF1**. By using the polarity information, the new reference input **REF2** for the digital filter unit **40** is generated. The new reference signal **REF2** is the same as the received electrode-tissue impedance signal **REF1** in case the received electrode-tissue impedance signal **REF1** has the same polarity as the measured ECG signal **BS2**, and the new reference signal **REF2** is a signal that has polarity opposite to the polarity of the electrode-tissue impedance signal **REF1** in case the received electrode-tissue impedance signal **REF1** has an opposite polarity than the measured ECG signal **BS2**.

[0018] According to an exemplary embodiment, the correlation value between the measured ECG signal **BS2** and the electrode-tissue impedance signal **REF1** may be also estimated by calculating the correlation between the estimated noise signal or motion artifact estimate **MA** at the output of the digital filter unit **40** and the electrode-tissue impedance signal **REF1.** According to another exemplary embodiment, the correlation value between the measured ECG signal **BS2** and the electrode-tissue impedance signal **REF1** may be estimated by calculating the correlation between the analogue ECG signal **BS1** and the electrode-tissue impedance signal **REF1**.

[0019] Advantageously, according to an exemplary embodiment of the invention, the new reference signal **REF2** has higher correlation with the measured ECG signal **BS2**, which improves the performance of the digital filter unit **40** for calculation of the motion artifact estimate **MA.** In consequence, the motion artifact estimate **MA** can be calculated faster and with more accuracy, which in turn improves motion artifact reduction.

[0020] According to an exemplary embodiment, the ECG signal acquisition system **100** works in real-time.

[0021] According to an exemplary embodiment, the digital filter unit **40** may implement or run a digital adaptive filter, for example, a Least Mean Square (LMS) filter. According to an exemplary embodiment, the reference signal processing unit **30** may be implemented as part of the digital filter unit **40**, for example, as part of the LMS filter. The digital filter unit **40** and the reference signal processing unit **30** may be implemented in hardware and/or software, in a dedicated digital domain part **60** and in the same chip as the analogue part **50**. According to an exemplary embodiment, the digital filter unit **40** and the reference signal processing unit **30** may be implemented in hardware and/or software in an off-chip or external microcontroller or microprocessor.

[0022] According to one exemplary embodiment, all the modules sown in **Figure 1** may be integrated on a single chip. This is advantageous for example to reduce the group delay for real time solution and/or to reduce the power consumption.

[0023] **Figure 2** shows a second exemplary block diagram of a ECG signal acquisition system **100** according to an embodiment of the invention. Basically the same working principle as the one explained **Figure 1** applies, but for the fact that now the reference signal processing unit **30** is implemented in the analogue domain part **50** and adapts the electrode-tissue impedance signal **REF1** in such domain.

[0024] **Figure 3** shows a simplified flow diagram of a method for acquisition of ECG signals with motion artifact reduction according to an embodiment of the invention. The method comprises, in a first step **S1**, calculating the correlation between a measured ECG signal **BS2** and an electrode-tissue impedance signal **REF1**; in a second step **S2**, calculating the polarity between the measured ECG signal **BS2** and an electrode-tissue impedance signal **REF1**; and, in a third step **S3**, generating a new reference signal **REF2** which is provided to a digital filter unit for motion artifact estimation.

[0025] According to an exemplary embodiment, the correlation value between a measured ECG signal **BS2** and an electrode-tissue impedance signal **REF1** is calculated in a first step **S1.** This may be done, in exemplary implementations, continuously and with a certain sampling rate in order to reduce the active power consumption. According to exemplary implementations, the estimated motion artifact signal **MA** may be also used for calculating the correlation value according to the equation:

$$corr_j = \frac{(dataIn\_A_j - \overline{dataIn\_A_{j-31:j}}) \cdot (dataIn\_B_j - \overline{dataIn\_B_{j-31:j}})}{32}$$

wherein *DataIn_A* is the motion artifact estimate signal **MA**, *DataIn_B* is the electrode-tissue impedance signal **REF 1** and *corr* is the correlation value. The sampling rate (32) may be changed and is a design option.

[0026] According to an exemplary embodiment, the correlation value may be +1 in case of a perfect positive (increasing) linear relationship (correlation), and -1 in case of a perfect decreasing (negative) linear relationship (anti-correlation), and some value between -1 and 1 in all other cases, indicating the degree of linear dependence between the variables. As it approaches zero there is less of a relationship (closer to uncorrelated).

[0027] According to an exemplary embodiment, after calculating the correlation value, a polarity calculation may be performed, for example as a polarity change request signal, *req_p*, which is generated as the following equation:

$$req\_p_j = \begin{cases} 0, \ \sum corr \geq CORR\_TH \\ 1, \ \sum corr < CORR\_TH \end{cases}$$

[0028] Where *corr* is the correlation value and *CORR_TH* is a certain threshold value. To avoid the oscillation, once the polarity is updated, it may stay for a certain period of time, for example at least for 1 second. This period of time can be programmed and is a design option.

[0029] According to an exemplary embodiment, by using polarity information, the new reference input **REF2** for the digital filter is updated as in the following equation:

$$ref_{neg} = REF\_OFF \ \times 2 - ref_{pos}$$

$$ref_{new} = \begin{cases} ref_{pos}, \ polarity = 0 \\ ref_{neg}, \ polarity = 1 \end{cases}$$

where *refpos* is the electrode-tissue impedance input, and *refneg* is the electrode-tissue impedance signal with opposite polarity. *REF_OFF* is a reference offset, which may be designed according to the acquisition environment such as subject, type of electrode, quality of electrode, etc., and its value may be adjusted at the beginning, and updated regularly during the operation.

[0030] **Figure 4** illustrates exemplary graphs of the measured ECG signal **BS2**, the electrode-tissue impedance signal **REF1** and the new reference signal **REF2** generated in a ECG signal acquisition system according to an embodiment of the invention. As illustrated in the figure, the new reference signal **REF2** is an adaptation of the electrode-tissue impedance signal **REF1**, in which the polarity of the electrode-tissue impedance signal **REF1** changed such that it has a higher correlation with the measured ECG signal **BS2.**

Claims

1. An ECG signal acquisition system (100) comprising:

an analogue readout unit (10) configured to receive an analogue ECG signal (BS1) and to extract, from that received analogue ECG signal, an analogue measured ECG signal (BS2) and an analogue electrode-tissue impedance signal (REF1);
an ADC unit (20) configured to provide a digital version of the analogue measured ECG signal (BS2) and the analogue electrode-tissue impedance signal (REF1);
a reference signal processing unit (30) configured to convert the electrode-tissue impedance signal (REF1) into a new reference signal (REF2); wherein the reference signal processing unit is configured to perform a polarity calculation based on the correlation between the measured ECG signal (BS2) and the electrode-tissue impedance signal (REF1); and wherein the reference signal processing unit (30) generates a new reference signal (REF2) that is the same as the electrode-tissue impedance signal (REF1) if the polarity information has a first value indicating that the electrode-tissue impedance signal (REF1) has the same polarity as the measured ECG signal (BS2), or generates a new reference signal (REF2) that has a polarity opposite to the polarity of the electrode-tissue impedance signal (REF1) if the polarity information has a second value indicating that the electrode-tissue impedance signal (REF1) has an opposite polarity than the measured ECG signal (BS2);
a digital filter unit (40) configured to calculate a digital motion artifact estimate (MA) based on the digital version of the measured ECG signal (BS2) and the new reference signal (REF2) provided by the reference signal processing unit (30).

2. An ECG signal acquisition system according to claim 1, wherein the correlation between the measured ECG signal (BS2) and the electrode-tissue impedance signal (REF1) is estimated by calculating the correlation between the motion artifact estimate signal (MA) and the electrode-tissue impedance signal (REF1).

3. An ECG signal acquisition system according to claim 1, wherein the new reference signal (REF2) with a polarity opposite to the polarity of the electrode-tissue impedance signal (REF1) also considers a reference offset (REF_OFF)..

4. An ECG signal acquisition system according to any of the previous claims, wherein the reference signal processing unit (30) is implemented in an analogue domain part (50) or a digital domain part (60) of the system (100).

5. An ECG signal acquisition system according to any of the previous claims, wherein the digital filter unit (40) implements or runs a digital adaptive filter.

6. An ECG signal acquisition system according to claim 5, wherein the digital adaptive filter is an LMS filter.

7. Electronic device comprising an ECG signal acquisition system (100) according to any of claims 1 to 6.

8. A method for acquisition of ECG signals in an electronic system according to claims 1 to 6, comprising:

in an analogue readout unit (10), extracting, from an analogue ECG signal (BS1), an analogue measured ECG signal (BS2) and an analogue electrode-tissue impedance signal (REF1);
in a reference signal processing unit (30), converting the electrode-tissue impedance signal (REF1) into a new reference signal (REF2) based on the correlation between the measured ECG signal (BS2) and the electrode-tissue impedance signal (REF1); wherein a polarity is calculated based on the correlation between the measured ECG signal (BS2) and the electrode-tissue impedance signal (REF1); and wherein a new reference signal (REF2) is generated that is the same as the electrode-tissue impedance signal (REF1) if the polarity information has a first value indicating that the electrode-tissue impedance signal (REF1) has the same polarity as the measured ECG signal (BS2), or a new reference signal (REF2) is generated that has a polarity opposite to the polarity of the electrode-tissue impedance signal (REF1) if the polarity information has a second value indicating that the electrode-tissue impedance signal (REF1) has an opposite polarity than the measured ECG signal (BS2); and
in a digital filter unit (40), calculating a digital motion artifact estimate (MA) based on the digital version of the measured ECG signal (BS2) and the new reference signal (REF2).

Patentansprüche

1. ECG-Signalerfassungssystem (100), umfassend:

eine analoge Ausleseeinheit (10), konfiguriert, um ein analoges ECG-Signal (BS1) zu empfangen und aus dem empfangenen ECG-Signal ein analoges gemessenes ECG-Signal (BS2) und ein analoges Elektrode-Gewebe-Impedanzsignal (REF1) zu extrahieren;
eine ADC-Einheit (20), konfiguriert, um eine digitale Version des analogen gemessenen ECG-Signals (BS2) und des analogen Elektrode-Gewebe-Impedanzsignals (REF1) bereitzustellen;
eine Referenzsignal-Verarbeitungseinheit (30), konfiguriert, um das Elektrode-Gewebe-Impedanzsignal (REF1) in ein neues Referenzsignal (REF2) umzuwandeln; wobei die Referenzsignal-Verarbeitungseinheit konfiguriert ist, um eine Polaritätsberechnung auf Grundlage der Korrelation zwischen dem gemessenen ECG-Signal (BS2) und dem Elektrode-Gewebe-Impedanzsignal (REF1) durchzuführen; und wobei die Referenzsignal-Verarbeitungseinheit (30) ein neues Referenzsignal (REF2) erzeugt, das das gleiche ist wie das Elektrode-Gewebe-Impedanzsignal (REF1), wenn die Polaritätsinformation einen ersten Wert aufweist, der angibt, dass das Elektrode-Gewebe-Impedanzsignal (REF1) die gleiche Polarität aufweist wie das gemessene ECG-Signal (BS2), oder ein neues Referenzsignal (REF2) erzeugt, das eine der Polarität des Elektrode-Gewebe-Impedanzsignals (REF1) entgegengesetzte Polarität aufweist, wenn die Polaritätsinformation einen zweiten Wert aufweist, der angibt, dass das Elektrode-Gewebe-Impedanzsignal (REF1) eine dem gemessenen ECG-Signal (BS2) entgegengesetzte Polarität aufweist;
eine digitale Filtereinheit (40), konfiguriert, um eine digitale Bewegungsartefaktabschätzung (MA) auf Grundlage der digitalen Version des gemessenen ECG-Signals (BS2) und des durch die Referenzsignal-Verarbeitungseinheit (30) bereitgestellten neuen Referenzsignals (REF2) zu berechnen.

2. ECG-Signalerfassungssystem nach Anspruch 1, wobei die Korrelation zwischen dem gemessenen ECG-Signal (BS2) und dem Elektrode-Gewebe-Impedanzsignal (REF1) durch Berechnen der Korrelation zwischen dem Bewegungsartefaktabschätzungssignal (MA) und dem Elektrode-Gewebe-Impedanzsignal (REF1) abgeschätzt wird.

3. ECG-Signalerfassungssystem nach Anspruch 1, wobei das neue Referenzsignal (REF2) mit einer der Polarität des Elektrode-Gewebe-Impedanzsignals (REF1) entgegengesetzten Polarität auch einen Referenzoffset (REF_OFF) in Betracht zieht.

4. ECG-Signalerfassungssystem nach einem der vorstehenden Ansprüche, wobei die Referenzsignal-Verarbeitungseinheit (30) in einem analogen Domänenteil (50) oder einem digitalen Domänenteil (60) des Systems (100) implementiert ist.

5. ECG-Signalerfassungssystem nach einem der vorstehenden Ansprüche, wobei die digitale Filtereinheit (40) einen digitalen adaptiven Filter implementiert oder ausführt.

6. ECG-Signalerfassungssystem nach Anspruch 5, wobei der digitale adaptive Filter ein LMS-Filter ist.

7. Elektronische Vorrichtung, umfassend ein ECG-Signalerfassungssystem (100) nach einem der Ansprüche 1 bis 6.

8. Verfahren zum Erfassen von ECG-Signalen in einem elektronischen System nach Ansprüchen 1 bis 6, umfassend:

in einer analogen Ausleseeinheit (10), Extrahieren, aus einem analogen ECG-Signal (BS1), eines analogen gemessenen ECG-Signals (BS2) und eines analogen Elektrode-Gewebe-Impedanzsignals (REF1);
in einer Referenzsignal-Verarbeitungseinheit (30), Umwandeln des Elektrode-Gewebe-Impedanzsignals (REF1) in ein neues Referenzsignal (REF2) auf Grundlage der Korrelation zwischen dem gemessenen ECG-Signal (BS2) und dem Elektrode-Gewebe-Impedanzsignal (REF1); wobei auf Grundlage der Korrelation zwischen dem gemessenen ECG-Signal (BS2) und dem Elektrode-Gewebe-Impedanzsignal (REF1) eine Polarität berechnet wird; und wobei ein neues Referenzsignal (REF2) erzeugt wird, das das gleiche ist wie das Elektrode-Gewebe-Impedanzsignal (REF1), wenn die Polaritätsinformation einen ersten Wert aufweist, der angibt, dass das Elektrode-Gewebe-Impedanzsignal (REF1) die gleiche Polarität aufweist wie das gemessene ECG-Signal (BS2), oder ein neues Referenzsignal (REF2) erzeugt wird, das eine der Polarität des Elektrode-Gewebe-Impedanzsignals (REF1) entgegengesetzte Polarität aufweist, wenn die Polaritätsinformation einen zweiten Wert aufweist, der angibt, dass das Elektrode-Gewebe-Impedanzsignal (REF1) eine dem gemessenen ECG-Signal (BS2) entgegengesetzte Polarität aufweist; und
in einer digitalen Filtereinheit (40), Berechnen einer digitalen Bewegungsartefaktabschätzung (MA) auf Grundlage der digitalen Version des gemessenen ECG-Signals (BS2) und des neuen Referenzsignals (REF2).

Revendications

1. Système d'acquisition de signal ECG (100) comprenant :

une unité de lecture analogique (10) configurée pour recevoir un signal ECG analogique (BS1) et pour extraire, à partir de ce signal ECG analogique reçu, un signal ECG analogique mesuré (BS2) et un signal analogique d'impédance d'électrode-tissu (REF1) ;
une unité CAN (20) configurée pour fournir une version numérique du signal ECG analogique mesuré (BS2) et du signal analogique d'impédance d'électrode-tissu (REF1) ;
une unité de traitement de signal de référence (30) configurée pour convertir le signal d'impédance d'électrode-tissu (REF1) en un nouveau signal de référence (REF2) ; dans lequel l'unité de traitement de signal de référence est configurée pour effectuer un calcul de polarité sur la base de la corrélation entre le signal ECG mesuré (BS2) et le signal d'impédance d'électrode-tissu (REF1) ; et dans lequel l'unité de traitement de signal de référence (30) produit un nouveau signal de référence (REF2) qui est le même que le signal d'impédance d'électrode-tissu (REF1) si l'information de polarité a une première valeur indiquant que le signal d'impédance d'électrode-tissu (REF1) a la même polarité que le signal ECG mesuré (BS2), ou produit un nouveau signal de référence (REF2) qui a une polarité opposée à la polarité du signal d'impédance d'électrode-tissu (REF1) si l'information de polarité a une seconde valeur indiquant que le signal d'impédance d'électrode-tissu (REF1) a une polarité opposée au signal ECG mesuré (BS2) ;
une unité de filtre numérique (40) configurée pour calculer une évaluation d'artefact de mouvement numérique

(MA) sur la base de la version numérique du signal ECG mesuré (BS2) et du nouveau signal de référence (REF2) fourni par l'unité de traitement de signal de référence (30).

2. Système d'acquisition de signal ECG selon la revendication 1, dans lequel la corrélation entre le signal ECG mesuré (BS2) et le signal d'impédance d'électrode-tissu (REF1) est évaluée en calculant la corrélation entre le signal d'évaluation d'artefact de mouvement (MA) et le signal d'impédance d'électrode-tissu (REF1).

3. Système d'acquisition de signal ECG selon la revendication 1, dans lequel le nouveau signal de référence (REF2) avec une polarité opposée à la polarité du signal d'impédance d'électrode-tissu (REF1) considère également un décalage de référence (REF_OFF).

4. Système d'acquisition de signal ECG selon l'une quelconque des revendications précédentes, dans lequel l'unité de traitement de signal de référence (30) est mise en oeuvre dans une partie de domaine analogique (50) ou une partie de domaine numérique (60) du système (100).

5. Système d'acquisition de signal ECG selon l'une quelconque des revendications précédentes, dans lequel l'unité de filtre numérique (40) met en oeuvre ou fait fonctionner un filtre adaptatif numérique.

6. Système d'acquisition de signal ECG selon la revendication 5, dans lequel le filtre adaptatif numérique est un filtre LMS.

7. Dispositif électronique comprenant un système d'acquisition de signal ECG (100) selon l'une quelconque des revendications 1 à 6.

8. Procédé d'acquisition de signaux ECG dans un système électronique selon les revendications 1 à 6, comprenant :

dans une unité de lecture analogique (10), l'extraction, à partir d'un signal ECG analogique (BS1), un signal ECG analogique mesuré (BS2) et un signal analogique d'impédance d'électrode-tissu (REF1) ;
dans une unité de traitement de signal de référence (30), la conversion du signal d'impédance d'électrode-tissu (REF1) en un nouveau signal de référence (REF2) sur la base de la corrélation entre le signal ECG mesuré (BS2) et le signal d'impédance d'électrode-tissu (REF1) ; dans lequel une polarité est calculée sur la base de la corrélation entre le signal ECG mesuré (BS2) et le signal d'impédance d'électrode-tissu (REF1) ; et dans lequel un nouveau signal de référence (REF2) est produit qui est le même que le signal d'impédance d'électrode-tissu (REF1) si l'information de polarité a une première valeur indiquant que le signal d'impédance d'électrode-tissu (REF1) a la même polarité que le signal ECG mesuré (BS2), ou un nouveau signal de référence (REF2) est produit qui a une polarité opposée à la polarité du signal d'impédance d'électrode-tissu (REF1) si l'information de polarité a une seconde valeur indiquant que le signal d'impédance d'électrode-tissu (REF1) a une polarité opposée au signal ECG mesuré (BS2) ; et
dans une unité de filtre numérique (40), le calcul d'une évaluation d'artefact de mouvement numérique (MA) sur la base de la version numérique du signal ECG mesuré (BS2) et du nouveau signal de référence (REF2).

Figure 1

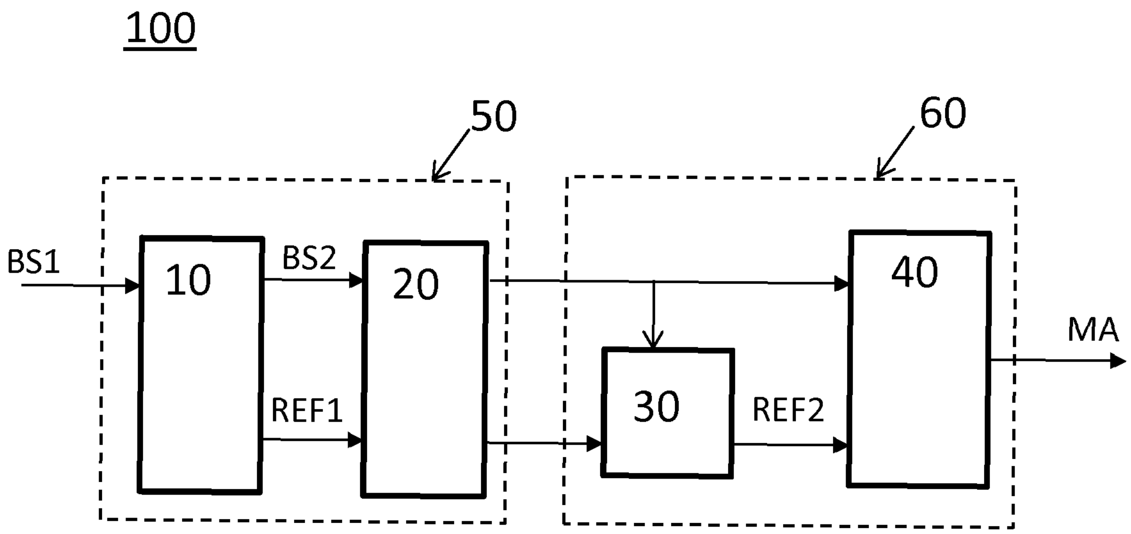


Figure 2

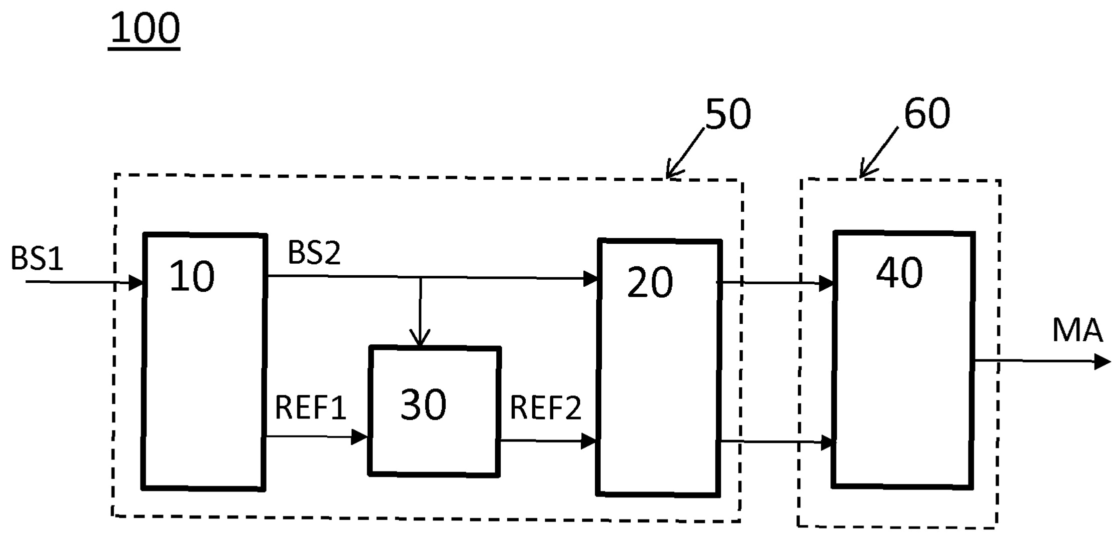


Figure 3

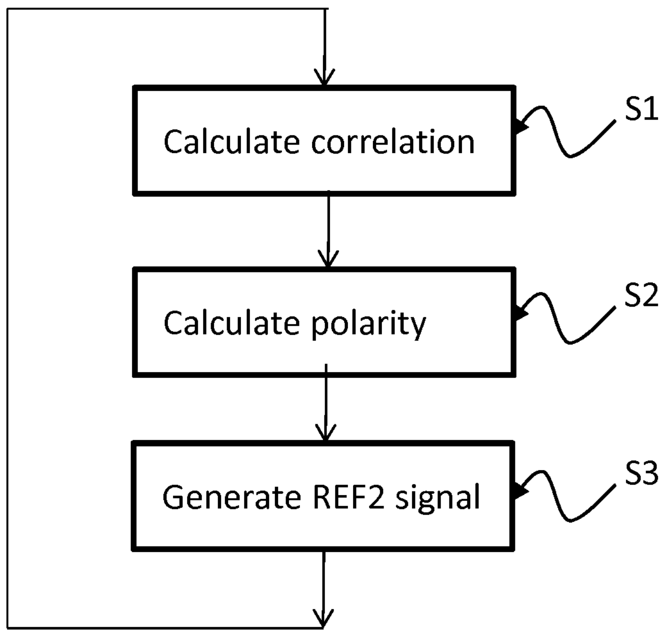
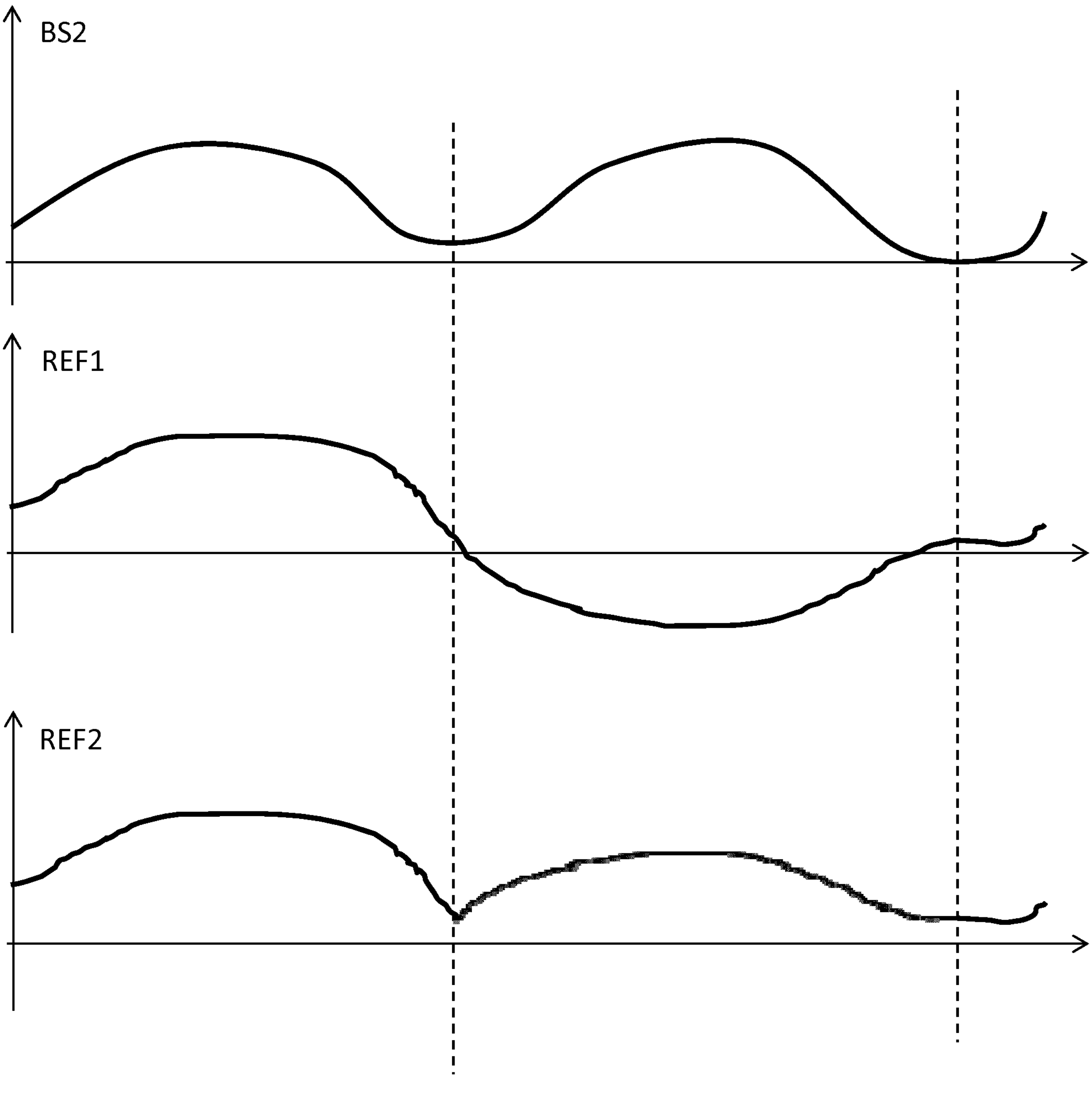

Calculate correlation
S1
Calculate polarity
S2
Generate REF2 signal
S3

Figure 4



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2591720 A1 **[0002]**

Non-patent literature cited in the description

- Motion Artifact Removal using Cascade Adaptive Filtering for Ambulatory ECG Monitoring System. **HYE-JUNG KIM et al.** Biomedical Circuits and Systems Conference (BioCAS). IEEE, November 2012 **[0002]**

patsnap

专利名称(译)	用于获取具有运动伪影减少的ECG信号的系统和方法。		
公开(公告)号	[EP2886044B1](EP2886044B1)	公开(公告)日	2019-08-28
申请号	EP2014156018	申请日	2014-02-20
[标]申请(专利权)人(译)	校际微电子中心		
申请(专利权)人(译)	IMEC		
当前申请(专利权)人(译)	IMEC VZW		
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IPC分类号	A61B5/00 A61B5/0428		
CPC分类号	A61B5/0428 A61B5/7214 A61B5/7246 A61B5/04017 A61B5/0402 A61B5/7207		
优先权	2013199276 2013-12-23 EP		
其他公开文献	EP2886044A1		
外部链接	Espacenet		

摘要(译)

本发明涉及一种生物电势信号采集系统（100），包括：模拟读出单元（10），被配置为接收模拟生物电势信号（BS1），其可以从连接到身体的至少一个电极获取;并提取模拟测量的生物电位信号（BS2）和模拟参考信号（REF1）; ADC单元（20），被配置为提供模拟测量的生物电势信号（BS2）和模拟参考信号（REF1）的数字版本;数字滤波器单元（40），被配置为基于所测量的生物电势信号（BS2）和参考信号（REF1）的数字版本来计算数字运动伪影估计（MA）。该系统还包括参考信号处理单元（30），其被配置为基于测量的生物电势信号（BS2）之间的相关性将参考信号（REF1）转换为提供给数字滤波器单元（40）的新参考信号（REF2）。 ）和参考信号（REF1）。本发明还涉及用于获取生物电势信号的电子设备和方法。

$$corr_j = \frac{\left(dataIn\_A_j - \overline{dataIn\_A_{j-31:j}}\right) \cdot \left(dataIn\_B_j - \overline{dataIn\_B_{j-31:j}}\right)}{32}$$