PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

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CROSS REFERENCE TO RELATED APPLICATIONS

[0002] This application claims priority to U.S. Provisional Application Ser. No. 61/434,862, filed January 21, 2011, entitled, "SYSTEM FOR QUANTIFYING THE PRESENCE OF PHASE COUPLING USING THE BISPECTRUM," U.S. Provisional Application Ser. No. 61/512,199, filed July 27, 2011, entitled, "PHYSIOLOGICAL PARAMETER MONITORING FROM OPTICAL RECORDINGS WITH A MOBILE PHONE," U.S. Provisional Application Ser. No. 61/434,856, filed January 21, 2011, entitled, SYSTEM AND METHOD FOR THE DETECTION OF BLOOD VOLUME LOSS," and U.S. Provisional Application Ser. No. 61/566,329, filed December 2, 2011, entitled, "TIME-VARYING COHERENCE FUNCTION FOR ATRIAL FIBRILLATION DETECTION," all of which are incorporated by reference herein in their entirety for all purposes.

BACKGROUND

[0003] These teachings relate generally to physiological parameter monitoring, and, more particularly, to physiological parameter monitoring with a mobile communication device.

[0004] There is a need for low-cost physiological monitoring solutions that are easy to use, accurate, and can be used in the home or in ambulatory situations. Smart phones are becoming more popular, more powerful and have a variety of sensors available to capture information from the outside world, process in real-time,

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and transfer information remotely using wireless communications. This makes them an ideal option as a 'take-anywhere' physiological monitor without the need for additional hardware, and their potential has been explored for many medical telemonitoring applications.

[0005] Optical video monitoring of the skin with a digital camera contains information related to the subtle color changes caused by the cardiac signal and can be seen to contain a pulsatile signal. Given illumination of the area with a white LED mobile phone flash, this type of imaging can be described as reflection photoplethysmographic (PPG) imaging. The dynamics of the HR signal that can be captured by PPG contain information that can be used to detect other physiological conditions.

[0006] Motion artifacts can affect the results of standard PPG. In the case of a mobile device and where there is no physical device ensuring a stable connection as is the case with pulse-oximeter clips or EKG electrodes, motion artifacts can be of more concern. There is a need for systems and methods for physiological monitoring with a mobile communication device that allow detection of motion artifacts.

BRIEF SUMMARY

[0007] The teachings described herein disclose systems and methods that enable physiological monitoring with a mobile communication device and that allow detection of motion artifacts so that the results reported are of acceptable quality are disclosed.

[0008] In one or more embodiments, the method of these teachings for physiological parameter monitoring includes providing a physiological indicator signal to a mobile communication device analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements

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of one or more physiological parameters and detecting, using the mobile communications device, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements.

[0009] Other embodiments and instances of the method of these teachings are also disclosed.

[0010] In one or more embodiments of the system of these teachings, the system includes a physiological indicator signal sensing component (sensor) and a mobile communication device having an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters and a motion artifact detection component detecting effects of motion artifacts in the measurements of the one or more physiological parameters.

[0011] Other embodiments and instances of the system of these teachings are also disclosed.

[0012] Embodiments and instances of computer usable media having computer readable code embodied therein, where the computer readable code causes one or more processors to implement the embodiments of the method of these teachings are also disclosed.

[0013] For a better understanding of the present teachings, together with other and further objects thereof, reference is made to the accompanying drawings and detailed description and its scope will be pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 is a flowchart representation of one embodiment of the method of these teachings;

[0015] Figure 1a is a schematic flowchart representations of components of one embodiment of the method of these teachings;

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[0016] Figure 1b is a schematic flowchart representations of components of another embodiment of the method of these teachings;

[0017] Figures 2a-2c are schematic graphical representations of results for one exemplary embodiment of the method of these teachings;

[0018] Figures 3a-3c are schematic graphical representations of results for another exemplary embodiment of the method of these teachings;

[0019] Figures 4a-4b are schematic graphical representations of results for yet another exemplary embodiment of the method of these teachings;

[0020] Figure 5 illustrates a schematic graphical representation of a resultant Time-Varying Coherence Function (TVCF) in a further exemplary embodiment of the method of these teachings;

[0021] Figures 6a and 6b are schematic graphical representations of the TVCF at different frequencies in the further exemplary embodiment of the method of these teachings;

[0022] Figures 7a-7c illustrate schematic graphical representations of true AF annotation and the values of frequency variations (FV) for different databases in the further exemplary embodiment of the method of these teachings; and

[0023] Figure 8 represents a schematic block diagram representation of one embodiment of the system of these teachings.

DETAILED DESCRIPTION

[0024] The following detailed description is of the best currently contemplated modes of carrying out these teachings. The description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating the general

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principles of these teachings, since the scope of these teachings is best defined by the appended claims. Although the teachings have been described with respect to various embodiments, it should be realized these teachings are also capable of a wide variety of further and other embodiments within the spirit and scope of the appended claims.

[0025] As used herein, the singular forms "a,""an," and "the" include the plural reference unless the context clearly dictates otherwise.

[0026] Except where otherwise indicated, all numbers expressing quantities of ingredients, reaction conditions, and so forth used in the specification and claims are to be understood as being modified in all instances by the term "about."

[0027] To assist in the understanding of the present teachings the following definitions are presented.

[0028] A "mobile communication device," as used herein, refers to a device capable of executing applications, and which is portable. In one instance, the mobile communication device has one or more processors and memory capability. Examples of mobile communication devices, these teachings not being limited to only these examples, include mobile phones, smart mobile phones, digital personal assistants, etc.

[0029] A "physiological indicator signal," as used herein, refers to a signal that can be used to obtain measurements of one or more physiological parameters. Examples of physiological indicator signals, these teachings not being limited only to those examples, include photoplethysmograph (PPG) signals, electrocardiogram (EKG) signals and color video images obtained from a portion of a subject's body (for example, but not limited to, obtained using the camera in a mobile communication device), which behave as reflection PPG images.

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[0030] "Volatility," as used herein, refers to a measure of the probability of obtaining an extreme value in the future , such as measured by kurtosis and other statistical measures.

[0031] "Detrending," as used herein, refers to the process of finding a best polynomial fit to a time series and subtracting that best polynomial fit from the time series.

[0032] "SpO2," as used herein, refers to a measurement of the amount of oxygen being carried by the red blood cell in the blood. SpO2 is usually given in as a percentage and measures oxygen saturation.

[0033] In one or more embodiments, the method of these teachings for physiological parameter monitoring includes providing a physiological indicator signal to a mobile communication device (step 5, Fig. 1), analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters (step 10, Fig. 1) and detecting, using the mobile communications device, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements (step 12, Fig. 1).

[0034] The physiological indicator signal can, in one instance, be provided by placing a portion of a subject's body over an objective lens of a camera in a mobile communication device and obtaining video images of the portion of the subject's body. In another instance, the physiological indicator signal can be provided by a physiological monitoring sensor, for example, an external photoplethysmographic (PPG) sensor or an external electrocardiogram sensor. It should be noted that other manners of providing the physiological indicator signal are within the scope of these teachings.

[0035] Motion artifacts

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[0036] One embodiment of the method for detecting effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements is disclosed hereinbelow. It should be noted that other embodiments are within the scope of these teachings.

[0037] In the embodiment shown in Fig. 1a, the method for detecting effects of motion artifacts includes preprocessing a segment of a signal (15, Fig. 1a) from a physiological measurement (20, Fig. 1a), obtaining a value of one or more indicators of volatility for the preprocessed segment (25, Fig. 1a) and determining from comparison of the value of the one or more indicators of volatility with a predetermined threshold whether or not noise/motion artifacts are not present. If noise/motion artifacts are not present, the segment is included in calculations quantities of interest (40, Fig. 1a) and the method proceeds to another segment (50, Fig. 1a), if another segment is available. If noise/motion artifacts are present, for most physiological parameters, the segment is discarded (45, Fig. 1a) and the method proceeds to another segment (50, Fig. 1a), if another segment is available. For the measurement of an indication of blood loss, as shown in Fig. 1b, a time-frequency spectrum analysis is performed for the preprocessed segment (30, Fig. 1b) and a predetermined measure of the time-frequency spectrum analysis is compared to a predetermined measure's threshold (35, Fig. 1b). If the predetermined measure is within limits determined by the predetermined measure's threshold, the segment is included in calculations quantities of interest (40, Fig. 1b) and the method proceeds to another segment, if another segment is available (50, Fig. 1b). If the predetermined measure is not within the limits determined by the predetermined measure's threshold, the segment is discarded (45, Fig. 1b) and

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the method proceeds to another segment (50, Fig. 1b), if another segment is available.

[0038] In one instance, the measure of volatility used in the above disclosed embodiment includes kurtosis. In another instance, the measure of volatility includes Shannon entropy. In a further instance, the measure of volatility uses both kurtosis and Shannon entropy.

[0039] An exemplary embodiment of the application of the method for detecting motion artifacts is described herein below in order to further elucidate these teachings. However it should be noted that these teachings are not limited to only that exemplary embodiments.

[0040] Experimental protocol for one exemplary embodiment

[0041] The algorithm has been tested on PPG signals obtained from two distinct scenarios as follows.

[0042] 1. Involuntary movements: Multi-site PPG signals recorded from 10 healthy volunteers under supine resting conditions for 5 to 20 minutes in clinical settings were used for our analysis. The data analyzed were a part of simulated blood loss experiments which consisted of baseline and lower body negative pressure application where the data from only the former condition was used for this study. Three identical reflective infrared PPG-probes (MLT1020; ADI Instruments, CO Springs, CO, USA) were placed at the finger, forehead and ear. While the finger and ear PPG probes were attached with a clip, the forehead probe was securely covered by a clear dressing. The PPG signals were recorded at 100 Hz with a Powerlab/16SPdata acquisition system equipped with a Quad Bridge Amp (ML795 & ML112; ADI Instruments) and a high-pass filter cut-off of 0.01 Hz. The subjects were not restricted from making any sort of movements during the recording procedure.

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[0043] 2. Voluntary movements: Finger-PPG signals were obtained from 14 healthy volunteers in an upright sitting posture using an infrared reflection type PPG transducer (TSD200) and a biopotential amplifier (PPG100) with a gain of 100 and cut-off frequencies of 0.05-10 Hz. The MP100 (BIOPAC Systems Inc., CA, USA) was used to acquire finger PPG signals at 100 Hz. After baseline recording for 5 minutes without any movements (i.e. clean data), motion artifacts were induced in the PPG data by left-right movements of the index finger with the pulse oximeter on it. The subjects were directed to produce the motions for time intervals that determined the percentage of noise within each 1 minute segment, varying from 10 to 50 %. For example, if a subject was instructed to make left-right movements for 6seconds, that segment of data would contain 10% noise. Such controlled movements were carried out 5 times for each level of noise. In this protocol, we used the left-right movement of the index finger having the PPG clamp to induce movement artifacts since left-right movement was perpendicular to the plane of the PPG sensor orientation and thus generated significant noise as compared to up-down or arbitrary movements of the finger. The recorded PPG signals from both protocols were analyzed offline using Matlab®.

[0044] B. Data Preprocessing:

[0045] The PPG data were partitioned into 60s segments and shifted every 10s for the entire data. Each 60s PPG segment was subjected to a finite impulse response (FIR) band pass filter of order 64 with cut-off frequencies of 0.1 Hz and 10 Hz. To account for the time-dependent low-frequency trends associated with the PPG signal and depending on the type of data analysis, either a low- or high-order polynomial detrending was used. For the purpose of artifact detection, we used in some cases as high as the 32nd-order polynomial fit to eliminate nonstationary

dynamics in the PPG signal. The use of a high-order polynomial detrend is important to an effective classification between clean and artifact-containing signals. For the time-frequency-spectral analysis during the second stage to determine usable data, a standard 2nd order polynomial detrend was used on the original PPG data (not on the data with a high-order polynomial detrend). Following detrend with either a low- or high-order polynomial fit, the PPG signal was zero-meaned. Before a computational analysis is conducted, the PPG waveforms in each data segment are visually examined and classified them into clean vs. corrupted segments. Any sort of disruption in the pulse characteristics was labeled as corrupted segments. This was done in order to later determine the accuracy of the method.

[0046] C. Computational measures for artifact detection

[0047] Following the preprocessing of each PPG data segment, our approach for the detection of artifacts involves the computation of the following two parameters.

[0048] Kurtosis: Kurtosis is a statistical measure used to describe the distribution of observed data around the mean. It represents a heavy tail and peakedness or a light tail and flatness of a distribution relative to the normal distribution. The kurtosis of a normal distribution is 3. Distributions that are more outlier-prone than the normal distribution have kurtosis greater than 3; distributions that are less outlier-prone have kurtosis less than 3. The kurtosis is defined as:

$$k = \frac{E(x-\mu)^4}{\sigma^4} \qquad (1)$$

Where μ is the mean of x, σ is the standard deviation of x, and $E(t)$ represents the expected value of the quantity t.

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[0049] Shannon entropy: SE quantifies how much the probability density function (PDF) of the signal is different from a uniform distribution and thus provides a quantitative measure of the uncertainty present in the signal. SE can be calculated as

$$SE = -\sum_{i=1}^{k} \frac{p(i)*\log[p(i)]}{\log(\frac{1}{k})} \qquad (2)$$

Where i represents the bin number, and $p(i)$ is the probability distribution of the signal amplitude. Presently, 16 bins $(k = 16)$ have been used to obtain a reasonably accurate measure of SE.

[0050] D. Statistical analysis of computational measures:

[0051] The nonparametric Mann Whitney test was conducted on data from the involuntary motion protocol to find the significance levels ($p<0.05$) for the SE and kurtosis measures between clean vs. corrupted PPG segments. Meanwhile, the nonparametric Kruskal-Wallis test with Dunn's multiple comparison post test was conducted on data from the voluntary motion protocol to find the significance ($p<0.05$) between clean vs. noise-corrupted PPG segments for the two measures.

[0052] E. Detection of motion/noise artifacts:

[0053] By varying kurtosis values from 0 to 10 with an increment of 0.1, and SE values from 0.5 to 1.0 with an increment of 0.01, receiver-operator characteristic (ROC) analysis were conducted for the population of SE and kurtosis values obtained from the respective pool of clean and corrupted PPG segments of both protocols. The substantially optimal threshold values for kurtosis and SE that produced the substantially optimal sensitivity and specificity for the detection of artifacts. (see, for example, S. H. Park et. al., Receiver Operating Characteristic (ROC) Curve: Practical Review for Radiologists, Korean J Radiol. 2004 Jan-Mar; 5(1): 11-18, which is Incorporated

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by reference herein is entirety for all purposes) where evaluated.

[0054] The decision rules for the detection of artifacts were formulated as follows:

$$DK_i = \begin{cases} 1 & if\ K_i \leq K_{Th} \\ 0 & if\ K_i > K_{Th} \end{cases} \quad (3)$$

where DK_i refers to the decision for artifact detection based on K_i, kurtosis for the i^{th} segment. '1' represents clean data, whereas '0' represents corrupted data. K_{Th} refers to the Kurtosis threshold.

$$DS_i = \begin{cases} 1 & if\ SE_i \geq SE_{Th} \\ 0 & if\ SE_i < SE_{Th} \end{cases} \quad (4)$$

where DS_i refers to the decision for artifact detection based on SE_i, SE for the i^{th} segment. '1' represents clean data whereas '0' represents corrupted data. SE_{Th} refers to the SE threshold.

[0055] The fusion of kurtosis and SE metrics with their substantially optimal threshold values for the artifact detection was further consider and the sensitivity and specificity for the fusion of these two metrics was quantified. The decision rule for the detection of artifacts using a fusion of kurtosis and SE is:

$$FD_i = \begin{cases} 1 & if\ DK_i + DS_i = 2 \\ 0 & if\ DK_i + DS_i \neq 2 \end{cases} \quad (5)$$

where FD_i refers to the fusion decision for artifact detection based on both DK_i and DS_i for the i^{th} segment. '1' represents clean data whereas '0' represents corrupted data.

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[0056] Time-frequency spectral analysis for the assessment of severity of noise

[0057] In the second stage of this embodiment of the motion/Noise Artifact algorithm, where blood loss is being detected, how severe the noise must be to affect the dynamics of the signal in the HR frequency range is assessed (shown in Fig. 1b). Specifically, this second stage determines if some of the segments that were deemed to contain artifacts can be used for noninvasive blood loss detection, as these data may not be heavily contaminated.

[0058] This step first requires the computation of time-frequency analysis so that the amplitude modulations at each time point within the heart rate band can be obtained. This extracted amplitude modulation information is subsequently used to determine the state of usable data as detailed in the proceeding section. A time-frequency method known as the variable frequency complex demodulation method (VFCDM) to be described hereafter is used because it has been shown to provide one of the highest time-frequency resolutions.

[0059] VFCDM Analysis: The development of the VFCDM algorithm has been previously disclosed in K. H. Chon, S. Dash, and K. Ju, "Estimation of respiratory rate from photoplethysmogram data using time-frequency spectral estimation," IEEE Trans Biomed Eng, vol. 56, no. 8, pp. 2054-63, Aug, 2009 and in U.S. Patent Application Publication 20080287815, published on November 20, 2008, corresponding to U.S. Patent Application No. 11/803,770, filed on May 16, 2007, both of which are incorporated by reference herein in their entirety for all purposes. Thus the VFCDM algorithm will be only briefly summarized hereinbelow.

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[0060] Consider a sinusoidal signal x(t) to be a narrow band oscillation with a center frequency f0, instantaneous amplitude A(t), phase $\phi(t)$, and the direct current component dc(t):

$$x(t) = dc(t) + A(t)\cos\left(2\pi f_0 t + \phi(t)\right) \qquad (6)$$

[0061] For a given center frequency, the instantaneous amplitude information A(t) and phase information $\phi(t)$ can be extracted by multiplying (6) by $e^{-j2\pi f_0 t}$, which results in the following:

$$z(t) = x(t)e^{-j2\pi f_0 t} = dc(t)e^{-j2\pi f_0 t} + \left(\frac{A(t)}{2}\right)e^{j\phi(t)} + \left(\frac{A(t)}{2}\right)e^{-j(4\pi f_0 t+\phi(t))} \qquad (7)$$

[0062] A leftward shift by $e^{-j2\pi f_0 t}$ results in moving the center frequency f0 to zero frequency in the spectrum of z(t). If z(t) in (7) is subjected to an ideal low-pass filter (LPF) with a cut-off frequency $f_c < f_0$, then the filtered signal $z_{lp}(t)$ will contain only the components of interest and the following can be extracted:

$$z_{lp}(t) = \frac{A(t)}{2}e^{j\phi(t)} \qquad (8)$$

$$A(t) = 2\left|z_{lp}(t)\right| \qquad (9)$$

$$\phi(t) = \tan^{-1}\frac{imag(z_{lp}(t))}{real(z_{lp}(t))} \qquad (10)$$

[0063] The method can easily be extended to the variable frequency case, where the modulating frequency is expressed as $\int_0^t 2\pi f(\tau)d\tau$ and the negative exponential term used for the demodulation is $e^{-j\int_0^t 2\pi f(\tau)d\tau}$. The instantaneous frequency can be obtained using the familiar differentiation of the phase information as follows:

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$$f(t) = f_0 + \frac{1}{2\pi}\frac{d\phi(t)}{d(t)} \qquad (11)$$

[0064] Thus, the VFCDM method involves a two-step procedure. At first, the fixed frequency complex demodulation technique identifies the signal's dominant frequencies, shifts each dominant frequency to a center frequency, and applies a low-pass filter (LPF) to each of the center frequencies. The LPF has a cutoff frequency less than that of the original center frequency and is applied to each dominant frequency. This generates a series of band-limited signals. The instantaneous amplitude, phase and frequency information are obtained for each band-limited signal using the Hilbert transform and are combined to generate a time-frequency series (TFS). Finally, the second step of the VFCDM method is to select only the dominant frequencies and produce a high-resolution TFS.

[0065] Once the TFS of the PPG signal is obtained via the VFCDM method, the largest instantaneous amplitude at each time point within the HR band (HR±0.2Hz) of the TFS of the VFCDM are extracted as the so-called AMHR components of the PPG that reflect the time varying amplitude modulation (AM) of the HR frequency. The initial and final 5s of the TFS were not considered for the AMHR extraction because time frequency series have an inherent end effect that could produce false variability of the spectral power. The median value of the AMHR components was evaluated for each corrupted PPG segment.

[0066] Determination of usable PPG segments corrupted with insignificant artifacts:

[0067] The AMHR median values were computed separately for clean PPG segments of each probe site for involuntary artifacts as well as for the voluntary artifact protocols as described

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above. The mean ± 2*SD of the AMHR median population were determined as their respective 95% statistical limits for each clean PPG data set. If the AMHR median value of the corrupted PPG segment lies within the statistical limits of the clean data, the respective corrupted PPG segment was considered as usable data; otherwise it was rejected. Thus, the model of our algorithm outlined in Fig. 1 has been designed to function in two separate stages for the detection and quantification of usable data among those that contain artifacts in PPG signals. Referring to Fig. 1a, a segment of a signal (15, Fig. 1) from PPG is preprocessed (filtered) (55, Fig. 1a), one or more indicators of volatility for the preprocessed segment are evaluated (60, Fig. 1a) to determine from comparison of the value of the one or more indicators of volatility with a predetermined threshold whether or not noise/motion artifacts are not present. If noise/motion artifacts are not present, the segment is included in calculations quantities of interest (65, Fig. 1) and the method proceeds to another segment, if another segment is available. If noise/motion artifacts are present, a time-frequency spectrum analysis is performed for the preprocessed segment and a predetermined measure of the time-frequency spectrum analysis, AMHR, is compared to a predetermined measure's threshold, the mean ± 2*Standard deviations (SD) of the AMHR median population of a clean sample. If the predetermined measure is within limits determined by the predetermined measure's threshold, the segment is included in calculations quantities of interest and the method proceeds to another segment, if another segment is available). If the predetermined measure is not within the limits determined by the predetermined measure's threshold, the segment is discarded and the method proceeds to another segment, if another segment is available.

[0068] Heart Rate And Heart Rate Variability Detection

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[0069] In one instance, the physiological measurements are heart rate and heart rate variability. In one embodiment, the method of these teachings for obtaining measurements of heart rate and heart rate variability includes determining beats for the physiological indicator signal (examples of beat detection algorithm, these teachings not be limited to those examples, can be found in Beat Detection Algorithms, available at http://www.flipcode.com/misc/BeatDetectionAlgorithms.pdf and accessed on January 17, 2012), determining beat to beat intervals and applying a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

[0070] The method for detection of beat to beat variability disclosed in United States Patent Application No. 20110166466, entitled RR INTERVAL MONITORING METHOD AND BLOOD PRESSURE CUFF UTILIZING SAME, published on July 7, 2011, which is incorporated by reference herein is entirety for all purposes, could be applied. Also, the methods for detection of the autonomous system imbalance disclosed in United States Patent Application 20090318983, entitled Method And Apparatus For Detection And Treatment Of Autonomic System Imbalance, published on December 24, 2009, which is Incorporated by reference herein is entirety for all purposes, could be applied.

[0071] In another instance, the physiological measurement is respiratory rate. One embodiment of the method for obtaining measurements of respiratory rate includes obtaining time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM) and obtaining respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

[0072] An exemplary embodiment of the measurement of heart rate and heart rate variability and respiratory rate is presented

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hereinbelow in order to further elucidate these teachings. It should be noted that these teachings are not limited to the exemplary embodiment.

[0073] In order to compare the exemplary embodiment of the present teachings to conventional methods, experiments were performed to measure the heart rate, heart rate variability and respiratory rate using conventional techniques. Electrocardiogram (EKG) recordings were made with an HP 78354A acquisition system using the standard 5-lead electrode configuration. A respiration belt was attached around the subject's chest to monitor breathing rate (Respitrace Systems, Ambulatory Monitoring Inc.). Respiratory and EKG recordings were saved using LabChart software (ADInstruments) at a sampling rate of 400 Hz.

[0074] Data were recorded during spontaneous breathing for a single subject. Data collection was initiated as follows: (1) initiate mobile phone video recording, (2) start recordings of EKG and respiration trace 10 seconds after initiation of mobile phone recording, and (3) set mobile phone down and place subject's left index finger over camera lens. This procedure allowed for alignment of data files to within 1 second.

[0075] Metronome breathing experiments were performed on a single subject with rates set at 0.2, 0.3, and 0.4 Hz (12, 18, and 24 Beats per Minute (BPM)). The subject was asked to inhale with each beat of the metronome. Metronome recordings were made for 2 minutes for each section.

[0076] For the measurements using the exemplary embodiment of these teachings, color changes of the finger were recorded using a Motorola Droid® (Motorola Mobility, Inc.) mobile phone. The palmar side of the left index finger was placed over the camera lens with the flash turned on. Subjects were instructed to rest their finger on the camera lens without pressing down with additional force, and to keep their finger still to reduce any

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motion artifacts. Videos were recorded with 720x480 pixel resolution at a sampling rate of 24.99 fps in .3gpp file format. The .3gpp videos were converted to Audio-Video Interleave (AVI) format at 720x480 pixel resolution and 25 fps using Pazera Free 3gp to AVI Converter 1.3 (http://www.pazera-software.com/). All further analysis was performed on the AVI videos in Matlab R2010b (The Mathworks Inc.)

[0077] For experiments assessing HR, heart rate variability (HRV), and respiration rate, only the green band from the video recordings was used. A 50x50 pixel average of a region on the video signal at each frame was made for the green band. This signal is from herein referred to as GREEN.

[0078] R-wave peak detection was performed for the EKG signal using a custom peak detection algorithm. Beats were detected for the GREEN signal using a conventional algorithm. Beat-beat intervals were computed, and cubic splined to 4 Hz to obtain the continuous HR for each signal (HREKG and HRGREEN). The power spectral density (PSD) of HR was computed using Welch periodogram method.

[0079] A section 105 of an exemplary GREEN signal obtained during spontaneous breathing is shown in Fig. 2a. The pulse signal is similar to a traditional PPG signal obtained from a pulse-oximeter. Peak detection was performed to identify the HR signal, shown in Fig. 2b along with that obtained from an EKG after R-wave peak detection. The mean±SD was 92.2±5.3 for HREKG and 92.3±5.9 for HRGREEN.

[0080] The dynamics of the HR signals- HRGREEN 110, HREKG 120 shown in Fig. 2b were assessed by frequency analysis (Fig. 2c). The dominant peak on both signals is seen to be at a low frequency <0.1 Hz. A second peak is seen on both signals in the sympathetic range (0.04 - 0.15 Hz), and a third peak at approximately 0.2 Hz is representative of the respiration rate.

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Additional high frequency components are seen in HRGREEN 112 compared to HREKG, possibly from the suboptimal low sampling frequency of the mobile phone recording.

[0081] Respiration Rate Detection

[0082] Frequency modulation (FM) and amplitude modulation (AM) sequences were extracted as described in K. H. Chon, S. Dash, and K. Ju, "Estimation of respiratory rate from photoplethysmogram data using time-frequency spectral estimation," IEEE Trans Biomed Eng, vol. 56, no. 8, pp. 2054-63, Aug, 2009 and in U.S. Patent Application Publication 20080287815, published on November 20, 2008, corresponding to U.S. Patent Application No. 11/803,770, filed on May 16, 2007, both of which are incorporated by reference herein in their entirety for all purposes, and used to estimate the breathing rate (Fig. 3a&b). Breathing rates were confirmed by taking the PSD of the respiration trace during 3 periods of metronome breathing recorded with the metronome set at 0.2, 0.3, and 0.4 Hz. Breathing rates from the respiration trace and GREEN signal using the FM sequence were estimated at the three metronome rates as 0.18 and 0.16, 0.30 and 0.32, and 0.40 and 0.38 Hz, respectively. The PSDs of the FM sequence 210, 220, 232 and respiration trace 212, 222, 230 for the three breathing rates are shown in Fig. 3c.

[0083] Oxygen Saturation Detection

[0084] In yet another instance, the physiological measurement is a measure of oxygen saturation. In one embodiment, the physiological indicator signal is acquired by placing a portion of a subject's body over an objective lens of a camera in a mobile communication device and obtaining video images of the portion of the subject's body. In that embodiment, the method of these teachings for obtaining a measure of oxygen saturation includes obtaining an average intensity of a red component and a blue component of the video images of the portion of the

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subject's body, the average intensity of the red component and the average intensity of the blue component constituting DCRED and DCBLUE respectively, obtaining a standard deviation of the red component and the blue component, the standard deviation of the red component and the blue component constituting ACRED and ACBLUE respectively, and obtaining the measure of oxygen saturation (SpO2) by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

[0085] An exemplary embodiment of the measure of oxygen saturation is presented hereinbelow in order to further elucidate these teachings. It should be noted that these teachings are not limited to the exemplary embodiment.

[0086] In order to compare the exemplary embodiment of the present teachings to conventional methods, experiments were performed to measure oxygen saturation.

[0087] Breath holding experiments were performed to assess the impact of reduced oxygen saturation on the optical recordings on two subjects. A commercial reflectance pulse-oximeter (Radical SETTM, Masimo) was placed on the left ring finger to record 1 sec measurements of SpO2. The mobile phone camera lens was placed underneath the subjects' left index fingertip. A black cloth was placed around the finger on the camera lens to isolate the sensor from light emanating from the commercial pulse-oximeter. The data files were aligned by starting the data logging of the pulse-oximeter by verbal command after the mobile phone recording started, and using the audio file to determine the initiation time point.

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[0088] Subjects were asked to breathe normally for approximately 30 seconds, exhale, and then to hold their breath till they felt discomfort. Two consecutive breath holding periods were recorded for each subject.

[0089] Oxygen Saturation Monitoring

[0090] The ratio of RED and BLUE in the equation for SpO provided hereinabove was computed and the A and B parameters were estimated for each subject using the commercial pulse-oximeter SpO2 values as a reference. For the subject shown in Fig. 4a, A and B in $SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}$ were determined to be 154.5 and 220.3, respectively, and for the subject in Fig. 4b, A and B were determined to be 155.7 and 265.5. (In Figs. 4a and 4b, measurements from the pulse oxymeter are labeled 310, 312, while measurements from these teachings are labeled 320, 322. It can be observed in Fig. 4a, 4b that SpO_2 decreases monitored with the commercial pulse-oximeter appear to cause decreases in our computed SpO_2 value obtained from the mobile phone recording. For the subject in Fig. 4a, a minimum SpO_2 level of 84% was recorded from the commercial pulse-oximeter and a minimum of 81% was computed with

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

[0091] It should be noted that, although offline analysis we performed in the above exemplary embodiments, given the current processing power available in mobile phones (currently 1GHz dual-core processors available), performing the analysis directly on a mobile phone is within the scope of these teachings.

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[0092] Blood Loss Detection

[0093] In a further instance, the physiological measurement is a measure of blood loss. One embodiment of the method for obtaining a measure of blood loss includes obtaining time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM), obtaining the amplitude modulation (AM) series from a set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time-frequency spectrum and determining whether the amplitude modulation decreases, a decrease in the amplitude modulation indicating blood volume loss in the subject.

[0094] An exemplary embodiment of the method for obtaining a measure of blood loss is disclosed in U.S. Provisional Application Ser. No. 61/434,856, filed January 21, 2011, entitled, SYSTEM AND METHOD FOR THE DETECTION OF BLOOD VOLUME LOSS" and in Nandakumar Selvaraj, Christopher G. Scully, Kirk H. Shelley, David G. Silverman, and Ki H. Chon, Early Detection of Spontaneous Blood Loss using Amplitude Modulation of Photoplethysmogram, 33rd Annual International Conference of the IEEE EMBS Boston, Massachusetts USA, August 30 - September 3, 2011, both of which are incorporated by reference herein in their entirety for all purposes.

[0095] Other embodiments of the method for obtaining a measure of blood loss are disclosed in WIPO International Publication No. WO 2011/050066 A2, entitled "Apparatus And Method For Respiratory Rate Detection And Early Detection Of Blood Loss Volume," published on April 28, 2011, which is incorporated by reference herein in its entirety for all purposes.

[0096] Atrial Fibrillation Detection

[0097] In a further instance, the physiological measurement is a measure of atrial fibrillation. One embodiment of the method

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for obtaining a measure of atrial fibrillation includes obtaining a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF, the second TVTF is produced by reversing the input and output signals and determining whether the time-varying coherence function (TVCF) is less than a predetermined quantity. In another embodiment, determining whether the time-varying coherence function is less than the predetermined quantity includes obtaining one or more indicators of atrial fibrillation and determining whether the one or more indicators of atrial fibrillation exceed predetermined thresholds. In one instance, the one or more indicators of atrial fibrillation include a variance of the time-varying coherence function. In another instance, the one or more indicators of atrial fibrillation also include Shannon entropy. In yet another instance, the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

[0098] In the embodiment of the method for obtaining a measure of atrial fibrillation disclosed hereinabove, the TVCF is estimated by the multiplication of two time-varying transfer functions (TVTFs). The two TVTFs are obtained using two adjacent data segments with one data segment as the input signal and the other data segment as the output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals. It has been found that the resultant TVCF between two adjacent normal sinus rhythm segments show high coherence values (near 1) throughout the entire frequency range. However, if either or both segments partially or fully contain AF, the resultant TVCF is significantly lower than 1. When TVCF was combined with Shannon entropy (SE), even more accurate AF

detection rate of 97.9% are obtained for the MIT-BIH Atrial Fibrillation (AF) database (n=23) with 128 beat segments.

[0099] In the embodiment disclosed herein above, the TVCF is obtained by the multiplication of the two time-varying transfer functions. To demonstrate the use of the TVTF in obtaining the TVCF, the TVCF is first defined via the nonparametric time-frequency spectra as

$$|\gamma(t,f)|^4 = \frac{|S_{xy}(t,f)|^2}{S_{xx}(t,f)S_{yy}(t,f)} \frac{|S_{yx}(t,f)|^2}{S_{yy}(t,f)S_{xx}(t,f)} \qquad (12)$$

where $S_{xy}(t,f)$ and $S_{yx}(t,f)$ represent the time-frequency cross-spectrum, and $S_{xx}(t,f)$ and $S_{yy}(t,f)$ represent the auto spectra of the two signals x and y, respectively. Specifically, the first term in Eq. (12) is the coherence function when x is considered as the input and y as the output. Similarly, the second term in Eq. (12) is the coherence function when y is considered as the input and x as the output. For a linear time varying (TV) system with x as the input and y as the output, the TVTF in terms of time-frequency spectra can be obtained as

$$H_{x\to y}(t,f) = \frac{S_{xy}(t,f)}{S_{xx}(t,f)} \qquad (13)$$

where $H_{x\to y}(t,f)$ is the TVTF from the input x to the output y signal. Similarly, for a linear TV system with y as the input and x as the output, the TVTF can be obtained as

$$H_{y\to x}(t,f) = \frac{S_{yx}(t,f)}{S_{yy}(t,f)} \qquad (14)$$

[00100] Thus, the time-varying magnitude $|\gamma(t,f)|^2$ is obtained by multiplying the two transfer functions,

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$$\left|H_{x\to y}(t,f)H_{y\to x}(t,f)\right| \qquad (15)$$

[00101] Given the relationship of (15), a high resolution TVCF can be obtained from ARMA models:

$$y(n)=-\sum_{i=1}^{P_1}a(n,i)y(n-i)+\sum_{j=0}^{Q_1}b(n,j)x(n-j) \qquad (16\text{-}1)$$

$$x(n)=-\sum_{i=1}^{P_2}\alpha(n,i)x(n-i)+\sum_{j=0}^{Q_2}\beta(n,j)y(n-j) \qquad (16\text{-}2)$$

where (16-1) represents $y(n)$ as the output and $x(n)$ as the input. Similarly, (16-2) represents $x(n)$ as the output and $y(n)$ as the input. Given the ARMA models of (16), the two transfer functions of (15) can be obtained as

$$H_{x\to y}(n,e^{jw})=\frac{B(n,e^{jw})}{A(n,e^{jw})}=\frac{\sum_{i=0}^{Q_1}b(n,j)e^{-jwi}}{1+\sum_{i=1}^{P_1}a(n,i)e^{-jwi}}$$

$$H_{y\to x}(n,e^{jw})=\frac{\beta(n,e^{jw})}{\alpha(n,e^{jw})}=\frac{\sum_{i=0}^{Q_2}\beta(n,j)e^{-jwi}}{1+\sum_{i=1}^{P_2}\alpha(n,i)e^{-jwi}} \qquad (17)$$

[00102] Finally, the TVCF can be obtained by multiplying the two transfer functions as described in (17). For the parameter estimation, the time-varying optimal parameter search (TVOPS) criterion can be used, which has been shown to be accurate when applied to many diverse physiological signals. For the physiological signals considered, the TVOPS has been shown to be more accurate than the AIC, minimum description length (MDL) and the fast orthogonal search criterion. For TVOPS, time-varying coefficients are expanded onto a set of basis functions. It has been previously demonstrated that Legendre polynomials are a good

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choice for capturing dynamics that are smoothly changing with time.

[00103] AF Detection: Variance of TVCF

[00104] For AF detection, two adjacent beat segments with the length denoted as seg has been formulated using the following ARMA models:

$$S_{i+1:i+seg}(n) = -\sum_{i=1}^{P_1} a(n,i)S_{i+1:i+seg}(n-i) + \sum_{j=0}^{Q_1} b(n,j)S_{i+seg+1:i+2\cdot seg}(n-j)$$
$$S_{i+seg+1:i+2\cdot seg}(n) = -\sum_{i=1}^{P_1} a(n,i)S_{i+seg+1:i+2\cdot seg}(n-i) + \sum_{j=0}^{Q_1} \beta(n,j)S_{i+1:i+seg}(n-j) \quad (18)$$

where $S_{i+1:i+seg}(n)$ and $S_{i+seg+1:i+2\cdot seg}(n)$ are two adjacent RR interval time series from the $(i+1)^{th}$ to the $(i+seg)^{th}$ and from the $(i+seg+1)^{th}$ to the $(i+2\cdot seg)^{th}$, respectively. By substituting (18) into (17), the two transfer functions are obtained, and the TVCF is obtained by multiplication of the two TVCFs.

[00105] An exemplary embodiment of the measure of atrial fibrillation is presented hereinbelow in order to further elucidate these teachings. It should be noted that these teachings are not limited to the exemplary embodiment.

[00106] The detection algorithm was tested on four databases using 128 beat segments: the MIT-BIH AF database, the MIT-BIH normal sinus rhythm (NSR) database (n=18), the MIT-BIH Arrhythmia database (n=48), and a clinical 24-hour Holter AF database (n=15).

[00107] In order to illustrate AF detection, the TVCF are calculated using ARMA (P1=5,Q1=5) with the first order Legendre function for subject 8455 of the MIT-BIH AF database. The first order of Legendre polynomials was used as this choice resulted in the best accuracy for the MIT-BIH AF database (N=23). The

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optimal ARMA model order was found to be P1=5 and Q1=5 with seg=128, which will be explained in detail in the proceeding section. A 128 beat segment was used which was then shifted by 128 beats. A 64 point FFT was used, which resulted in a frequency resolution of 0.0156 Hz. Figure 5 shows the resultant TVCFs according to each beat and normalized frequency (assuming a Nyquist frequency of 0.5 Hz). As shown in Figure 5, the TVCF values are close to one throughout the entire frequency range for the two adjacent normal sinus rhythm (NSR) data segments. However, the TVCF values significantly decreased when either or both segments partially or fully contained AF.

[00108] As shown in Figure 5, it is observed that the TVCF values are highly varying for different frequencies when the patient is in AF. That is, high frequencies tend to have lower coherence values than lower frequencies, in AF (see Figures 6a, 6b). To illustrate this phenomenon in more detail, some of the TVCF values are shown selected at various frequencies from Figure 5 as a function of time in Figure 6(a). Figure 6(b) shows the corresponding average values of TVCF according to each normalized frequency and each 128-beat segment for both the AF and NSR databases. It is noted that for AF data, TVCF values start close to one at low frequencies but they drop to low values quickly as the frequency increases. However, for NSR data, the TVCFs are nearly constant (slightly decreasing) at near unit values for all frequencies. This can be explained by the fact that the selected ARMA model terms for AF include largely self and its delay of one lag terms (e.g. x(n), x(n-1), y(n) and y(n-1)), as expected, thus, TVCF values will be high only at the low frequencies and become lower as frequencies increase. Also note in the left panel of Figure 6, it is observed that the variance of TVCF values is significantly high for AF but nearly constant for NSR.

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[00109] Based on the latter observation as described above, AF detection is performed by examining the variance of TVCF through the entire frequency range. For each beat, the variance of TVCF values, termed the frequency variations (FV), is calculated among all frequencies. Using FV-TVCF, the AF detection performance was investigated on the entire MIT-BIH AF database.

[00110] Referring now to Figures 7A and 3B, FV-TVCF values and true AF annotation for three representative subjects 4048, 735 and 7162 of the MIT-BIH AF database are shown. In Figure 7(a), the data set 4048 contains seven AF episodes with lengths of 206, 66, 37, 34, 388, 40 and 42 beats, and the values of FV-TVCF increase in the beats where AF occurs. In Figs. 7(b), the data set 735 contains one AF episode with a length of 332 beats whereas for the dataset 7162, AF episodes persist for the entire time segment shown. The FV-TVCF values reflect this by never returning to a value of zero.

[00111] Ectopic Beat Elimination and Shannon Entropy Combination

[00112] A NSR segment including premature or ectopic beats may also result in lower TVCF values. In order to reduce the effect of the premature and ectopic beats, we eliminated outliers and filtered ectopic beats. To summarize, premature or ectopic beats can be recognized by their signature short-long RR sequence between normal RR intervals. For each RR interval in the time series, the ratio RR(i)/RR(i-1) was computed, where RR(i) is the ith beat, and eliminated RR(i) and RR(i+1) when the following three conditions were satisfied: 1) RR(i)/RR(i-1)<perc1, 2) RR(i+1)/RR(i)>perc99 and 3) RR(i+1)/RR(i+2)>perc25, where perc1, perc25 and perc99 are the 1st, 25th and 99th percentiles based on a histogram of the RR interval values, respectively.

[00113] Shannon entropy (SE) as in (19) was also combined with FV-TVCF, to increase the accuracy of AF detection. SE has been

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shown to be a robust detector of AF and is estimated according to the following calculation:

$$SE = -\sum_{u=1}^{N_{bin}} p(u)\frac{log(p(u))}{log(\frac{1}{N_{bin}})} \qquad (19)$$

[00114] Note that N_{bin} was selected for the best accuracy according to segment lengths while $N_{bin} = 16$ was selected.

[00115] Detector Optimization

[00116] In one embodiment, the condition for AF detection can be given by a simple logical AND condition:

- If (FV $\geq TH_{var}$) AND (SE $\geq TH_{SE}$), then classify it as AF.
- Else classify it as non-AF.

[00117] TH_{var} and TH_{SE} are the threshold values of the variance and the Shannon entropy, respectively, and are selected based on the best accuracy; specifically, we used receiver operator characteristic (ROC) analyses. For each combination of TH_{var} and TH_{SE}, the number of True Positives (TP), True Negatives (TN), False Positives (FP) and False Negatives (FN) were found, and used the accuracy (TP+TN)/(TP+TN+FP+FN) on the MIT-BIH AF database. In addition, the sensitivity TP/(TP+FN) and specificity TN/(TN+FP) were calculated. The procedure was repeated by changing the order of ARMA model and the lengths of segments. Note that the ARMA model order was restricted by setting P1=Q1. After finding the values of TH_{var} and TH_{SE} with each different number of model orders and lengths of segments, the same parameters were applied to the databases from MIT-BIH and the clinical AF database.

[00118] In another embodiment of the method for obtaining a measure of atrial fibrillation, the method, using the Root Mean Square of Successive Differences (RMSSD), disclosed in United States Patent Application No. 20110166466, entitled RR INTERVAL MONITORING METHOD AND BLOOD PRESSURE CUFF UTILIZING SAME,

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published on July 7, 2011, which is incorporated by reference herein is entirety for all purposes, is applied.

[00119] In one or more embodiments, the system of these teachings for physiological parameter monitoring includes a physiological indicator signal sensing component (sensor) and a mobile communication device having an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters and a motion artifact detection component detecting effects of motion artifacts in the measurements of the one or more physiological parameters.

[00120] In one instance, the mobile communication device includes one or more processors and one or more computer usable media, where the computer usable media has computer readable code embodied therein that causes the processor to analyze the physiological indicator signal to obtain measurements of one or more physiological parameters and to detect effects of motion artifacts in the measurements of the one or more physiological parameters. In one or more embodiments, the computer readable code causes the processor to implement the methods described hereinabove.

[00121] It should be noted that other embodiments of the mobile communication device, such as the use of ASICs or FPGAs in order to implement the analysis component and/or the motion artifact detection component are within the scope of these teachings.

[00122] Fig. 8 is a block diagram representation of one embodiment of the system of these teachings. Referring to Fig. 8, in the embodiment shown therein, a mobile communication system 280 includes a processor 250 and one or more memories 260. A physiological indicator signal sensing component (sensor) 270 supplies a physiological indicators signal to the mobile communication device 280. The sensor 270 can be a

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photoplethysmographic (PPG) sensor or an electrocardiogram (EKG) sensor. In the embodiment shown in Fig. 8, a camera 265, where the camera as an objective lens 267, can also supply the physiological indicators signal to the mobile communication device 280. The one or more memories 260 have computer usable code embodied therein that causes the processor 250 to that causes the processor to analyze the physiological indicator signal to obtain measurements of one or more physiological parameters and to detect effects of motion artifacts in the measurements of the one or more physiological parameters. In one or more instances, the computer readable code causes the processor 250 to perform the implement the methods described hereinabove.

[00123] The one or more memories 260 represent one embodiment of computer usable media having computer readable code embodied therein that causes a processor to implement the methods of these teachings. Embodiments of the method of these teachings are described hereinabove and the computer readable code can cause a processor to implement those embodiments.

[00124] In the embodiment shown in Fig. 8, the mobile communication device 280 also includes an antenna 265 that enables communications through one or more of a variety of wireless protocols or over wireless networks. It should be noted that, although the sensor 270 is shown as being directly connected to the mobile communication device 280, embodiments in which the sensor 270 provides the physiological indicators signal to the mobile communication device 280 through a wireless connection are also within the scope of these teachings.

[00125] For the purposes of describing and defining the present teachings, it is noted that the term "substantially" is utilized herein to represent the inherent degree of uncertainty that may be attributed to any quantitative comparison, value, measurement,

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or other representation. The term "substantially" is also utilized herein to represent the degree by which a quantitative representation may vary from a stated reference without resulting in a change in the basic function of the subject matter at issue.

[00126] Elements and components described herein may be further divided into additional components or joined together to form fewer components for performing the same functions.

[00127] Each computer program may be implemented in any programming language, such as assembly language, machine language, a high-level procedural programming language, or an object-oriented programming language. The programming language may be a compiled or interpreted programming language.

[00128] Each computer program may be implemented in a computer program product tangibly embodied in a computer-readable storage device for execution by a computer processor. Method steps of the invention may be performed by a computer processor executing a program tangibly embodied on a computer-readable medium to perform functions of the invention by operating on input and generating output.

[00129] Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CDROM, any other optical medium, any physical medium with patterns of holes, a RAM, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge, all of which are non-transitory. As stated in the USPTO 2005 Interim Guidelines for Examination of Patent Applications for Patent Subject Matter Eligibility, 1300 Off. Gaz. Pat. Office 142 (Nov. 22, 2005), "On the other hand, from a technological standpoint, a signal encoded with functional descriptive material is similar to a computer-readable memory encoded with functional descriptive material, in that they both create a functional interrelationship with a computer. In other

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words, a computer is able to execute the encoded functions, regardless of whether the format is a disk or a signal."

[00130] Although the invention has been described with respect to various embodiments, it should be realized these teachings are also capable of a wide variety of further and other embodiments within the spirit and scope of the appended claims.

[00131] What is claimed is:

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CLAIMS

1. A method for physiological parameter monitoring, the method comprising:

providing a physiological indicator signal to a mobile communication device;

analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters; and

detecting, using the mobile communications device, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements.

2. The method of claim 1 wherein the step of detecting effects of motion artifacts in the measurements comprises:

a. preprocessing a segment from the measurement of one physiological parameter;

b. obtaining a value of at least one indicator of volatility for the preprocessed segment;

c. including the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present; and

d. selecting another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available.

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3. The method of claim 2 wherein said at least one indicator of volatility comprises kurtosis.

4. The method of claim 2 wherein said at least one indicator of volatility comprises Shannon entropy.

5. The method of claim 2 wherein said at least one measure of volatility comprises kurtosis and Shannon entropy.

6. The method of claim 2 wherein the predetermined threshold is determined using receiver operator characteristic (ROC) analysis.

7. The method of claim 1 wherein providing a physiological indicator signal comprises:
placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and

obtaining video images of the portion of the subject's body.

8. The method of claim 1 wherein providing a physiological indicator signal comprises obtaining a signal from a physiological monitoring sensor.

9. The method of claim 8 wherein the physiological monitoring sensor is a photoplethysmographic (PPG) sensor or an electrocardiogram sensor.

10. The method of claim 1 wherein the one or more physiological measurements comprise heart rate and heart rate variability.

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11. The method of claim 10 wherein obtaining measurements of heart rate and heart rate variability comprise:
determining beats for the physiological indicator signal;

determining beat to beat intervals; and

applying a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

12. The method of claim 1 wherein the one or more physiological measurements comprise respiratory rate.

13. The method of claim 12 wherein measurement of respiratory rate comprises:
obtaining time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtaining respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

14. The method of claim 1 wherein the one or more physiological measurements comprise a measure of oxygen saturation.

15. The method of claim 14 wherein providing a physiological indicator signal comprises:
placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and

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obtaining video images of the portion of the subject's body, and

wherein obtaining the measure of oxygen saturation comprises:
obtaining an average intensity of a red component and a blue component of the video images of the portion of the subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtaining a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtaining the measure of oxygen saturation (SpO2) by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

16. The method of claim 1 wherein the one or more physiological measurements comprise a measure of blood loss.

17. The method of claim 16 wherein obtaining the measure of blood loss comprises:
obtaining time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

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obtaining the amplitude modulation (AM) series from a set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time-frequency spectrum; and

determining whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

18. The method of claim 1 wherein the one or more physiological measurements comprise a measure of atrial fibrillation.

19. The method of claim 18 wherein obtaining the measure of atrial fibrillation comprises:

obtaining a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determining whether the time-varying coherence function is less than a predetermined quantity.

20. The method of claim 19 wherein determining whether the time-varying coherence function is less than the predetermined quantity comprises:
obtaining one or more indicators of atrial fibrillation; and

determining whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

21. The method of claim 20 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

22. The method of claim 21 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

23. The method of claim 20 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

24. A system for physiological parameter monitoring, the system comprising:
a physiological indicator signal sensing component; and a mobile communication device comprising:
an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters; and

a motion artifact detection component detecting effects of motion artifacts in the measurements of the one or more physiological parameters.

25. The system of claim 24 wherein the mobile communications device comprises:
at least one processor; and

at least one computer usable medium, the computer usable medium having computer readable code embodied therein, the

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computer readable code causing the at least one processor to:

analyze the physiological indicator signal to obtain measurements of one or more physiological parameters; and

detect effects of motion artifacts in the measurements of the one or more physiological parameters.

26. The system of claim 25 wherein the computer readable code, in causing the at least one processor to detect effects of motion artifacts, causes the at least one processor to:

a. preprocess a segment from the measurement of one physiological parameter;

b. obtain a value of at least one indicator of volatility for the preprocessed segment;

c. include the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present;

d. select another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available.

27. The system of claim 26 wherein said at least one indicator of volatility comprises kurtosis.

28. The system of claim 26 wherein said at least one indicator of volatility comprises Shannon entropy.

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29. The system of claim 26 wherein said at least one measure of volatility comprises kurtosis and Shannon entropy.

30. The system of claim 26 wherein the predetermined threshold is determined using receiver operator characteristic (ROC) analysis.

31. The system of claim 24 wherein the physiological indicator signal sensing component comprises an image acquisition component, said acquisition component capable of acquiring a number of frames, each frame acquired at a predetermined time.

32. The system of claim 31 wherein the mobile communications device comprises said image acquisition component.

33. The system of claim 24 wherein the physiological indicator signal sensing component comprises a physiological monitoring sensor.

34. The system of claim 33 wherein the physiological monitoring sensor is a photoplethysmographic (PPG) sensor or an electrocardiogram sensor.

35. The system of claim 25 wherein the physiological indicator signal sensing component comprises an image acquisition component, said acquisition component capable of acquiring a number of frames, each frame acquired at a predetermined time; wherein said image acquisition component acquires a color image having red, green and blue components; wherein one or more physiological measurements comprise a measure

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of oxygen saturation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain an average intensity of a red component and a blue component of the images of a portion of a subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtain a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtain the measure of oxygen saturation by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

36. The system of claim 25 wherein the one or more physiological measurements comprise heart rate and heart rate variability; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

determine beats for the physiological indicator signal; determine beat to beat intervals; and

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apply a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

37. The system of claim 25 wherein the one or more physiological measurements comprise respiratory rate; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtain respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

38. The system of claim 25 wherein the one or more physiological measurements comprise a measure of blood loss; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtain the amplitude modulation (AM) series from set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time-frequency spectrum; and

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determine whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

39. The system of claim 25 wherein the one or more physiological measurements comprise a measure of atrial fibrillation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determine whether the time-varying coherence function is less than a predetermined quantity.

40. The system of claim 39 wherein the computer readable code, in causing the at least one processor to determine whether the time-varying coherence function is less than the predetermined quantity, causes the at least one processor to:

obtain one or more indicators of atrial fibrillation; and determine whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

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41. The system of claim 40 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

42. The system of claim 41 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

43. The system of claim 41 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

44. A computer usable medium having computer readable code embodied therein, the computer readable code causing at least one processor to:

analyze a physiological indicator signal to obtain measurements of one or more physiological parameters; and

detect effects of motion artifacts in the measurements of the one or more physiological parameters.

45. The computer usable medium of claim 44 wherein the physiological indicator signal comprises a video color image having red, green and blue components, the video color image being an image obtained from of a portion of a subject's body; wherein the measurements of one or more physiological parameters comprise a measure of oxygen saturation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

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obtain an average intensity of the red component and a blue component of the video color image of a portion of a subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtain a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtain the measure of oxygen saturation by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

46. The computer usable medium of claim 44 wherein the one or more physiological measurements comprise heart rate and heart rate variability; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

determine beats for the physiological indicator signal;

determine beat to beat intervals; and

apply a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

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47. The computer usable medium of claim 44 wherein the one or more physiological measurements comprise respiratory rate; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtain respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

48. The computer usable medium of claim 44 wherein the one or more physiological measurements comprise a measure of blood loss; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to: obtain time-frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtain the amplitude modulation (AM) series from set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time-frequency spectrum; and

determine whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

49. The computer usable medium of claim 44 wherein the one or more physiological measurements comprise a measure of atrial fibrillation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determine whether the time-varying coherence function is less than a predetermined quantity.

50. The computer usable medium of claim 44 wherein the computer readable code, in causing the at least one processor to determine whether the time-varying coherence function is less than the predetermined quantity, causes the at least one processor to:

obtain one or more indicators of atrial fibrillation; determine whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

51. The computer usable medium of claim 50 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

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52. The computer usable medium of claim 51 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

53. The computer usable medium of claim 50 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

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ABSTRACT OF THE DISCLOSURE

Systems and methods that enable physiological monitoring with a mobile communication device and that allow detection of motion artifacts so that the results reported are of acceptable quality are disclosed.

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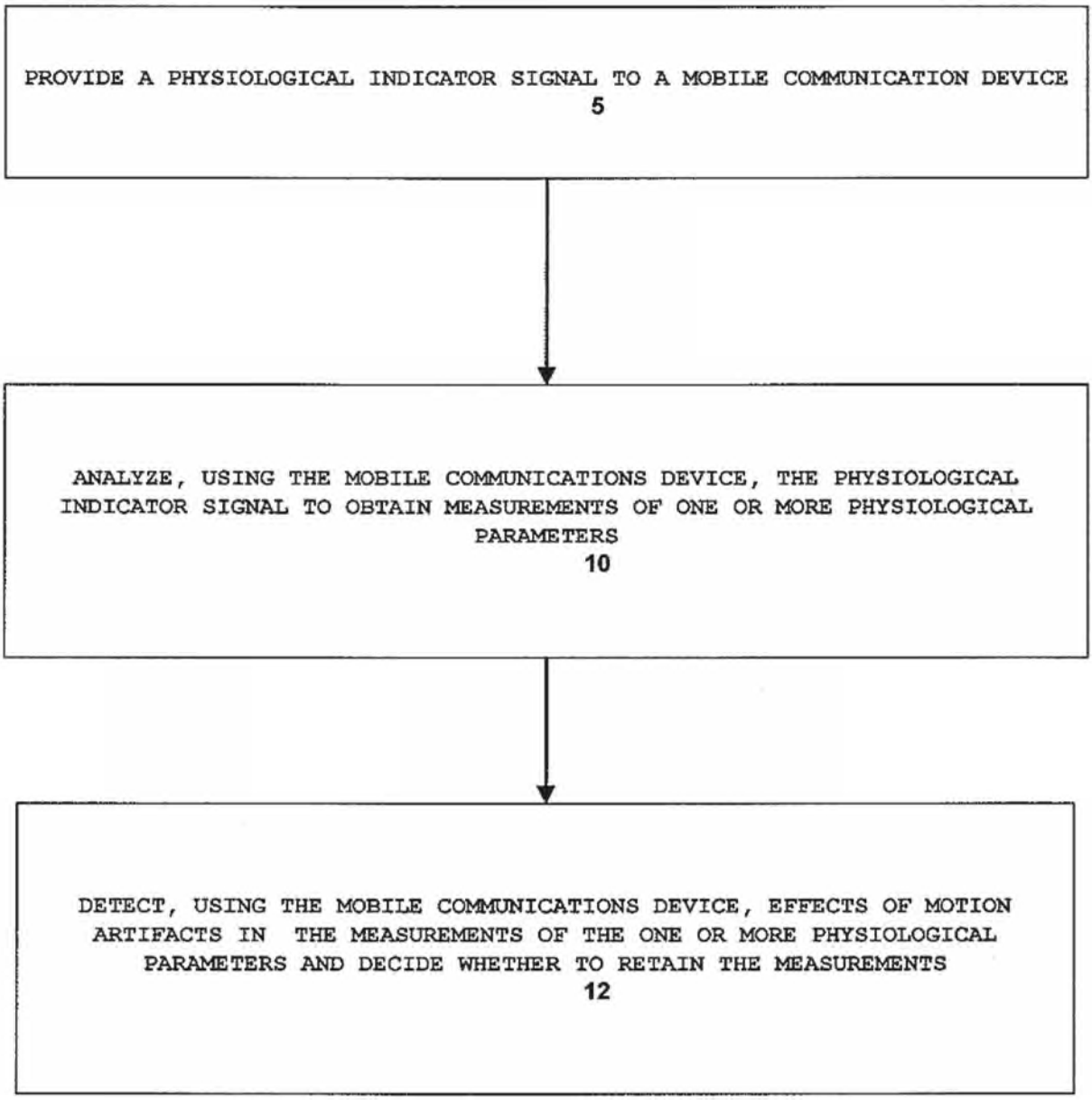

PROVIDE A PHYSIOLOGICAL INDICATOR SIGNAL TO A MOBILE COMMUNICATION DEVICE
5
ANALYZE, USING THE MOBILE COMMUNICATIONS DEVICE, THE PHYSIOLOGICAL INDICATOR SIGNAL TO OBTAIN MEASUREMENTS OF ONE OR MORE PHYSIOLOGICAL PARAMETERS
10
DETECT, USING THE MOBILE COMMUNICATIONS DEVICE, EFFECTS OF MOTION ARTIFACTS IN THE MEASUREMENTS OF THE ONE OR MORE PHYSIOLOGICAL PARAMETERS AND DECIDE WHETHER TO RETAIN THE MEASUREMENTS
12

Fig. 1

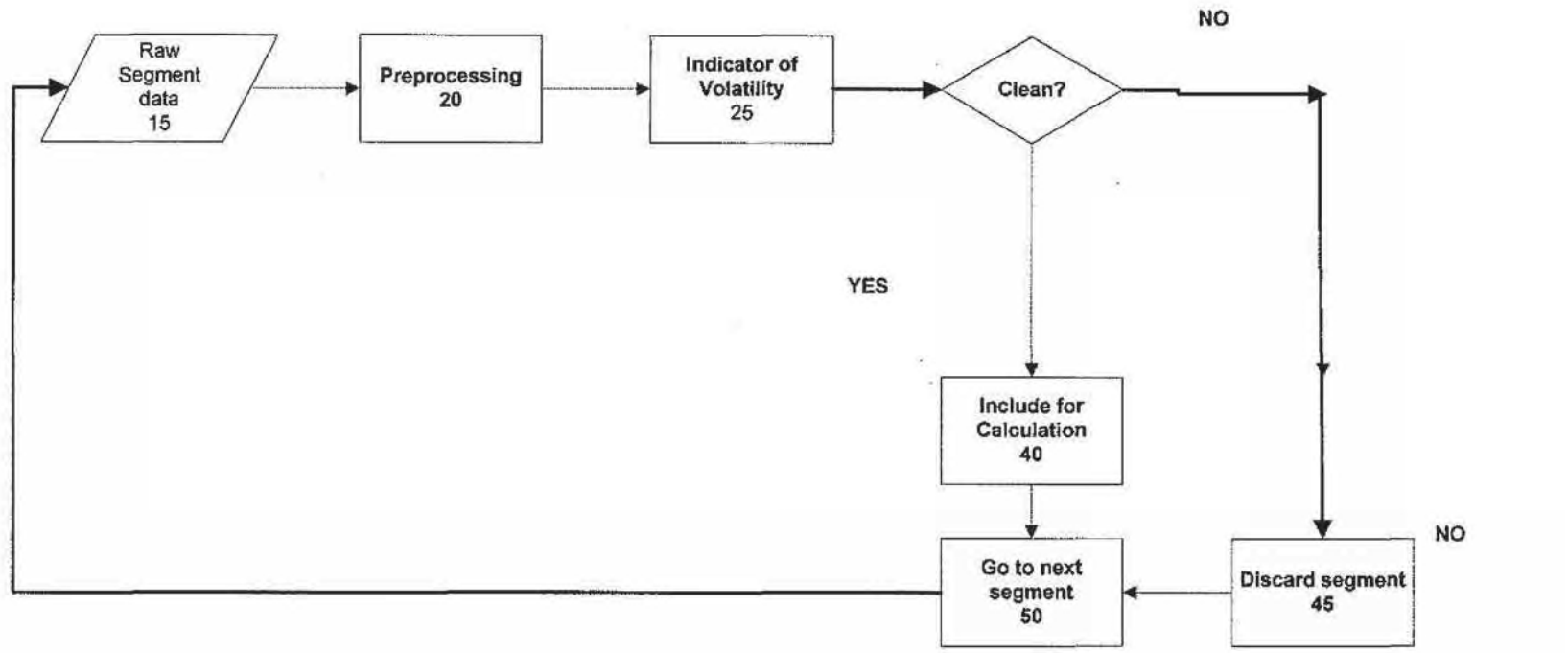


Fig. 1a

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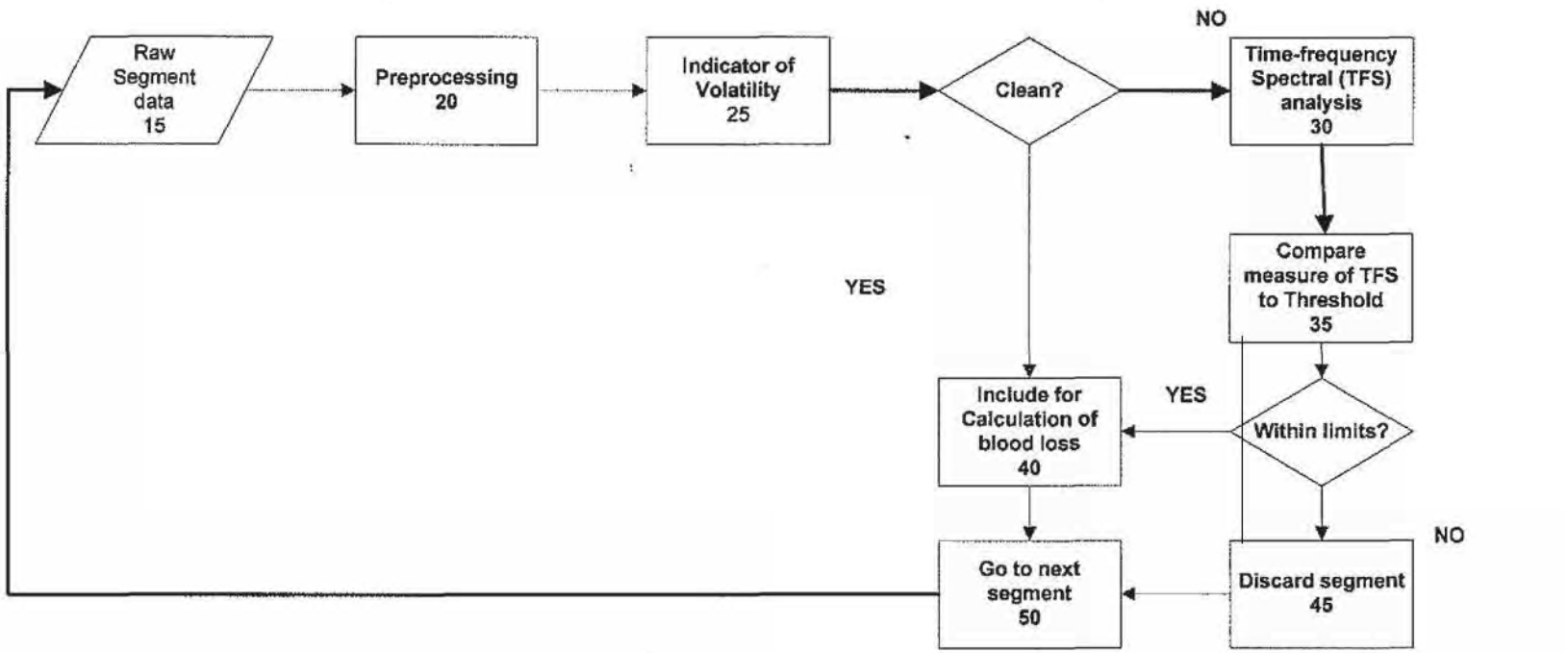
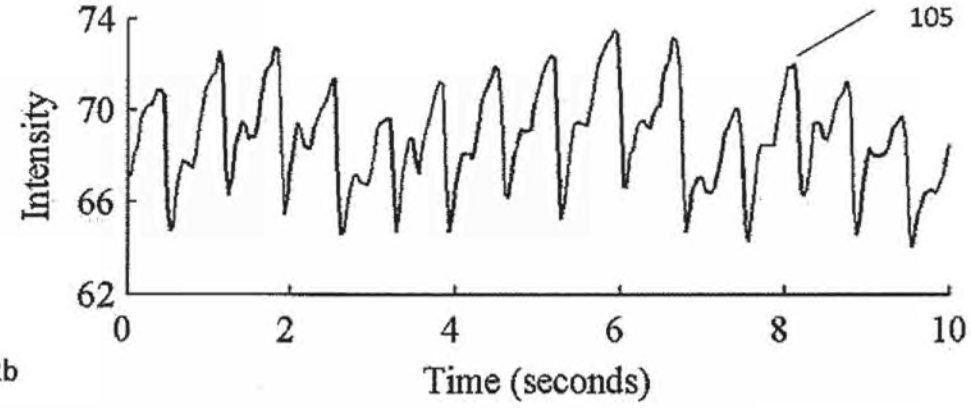


Fig. 1b

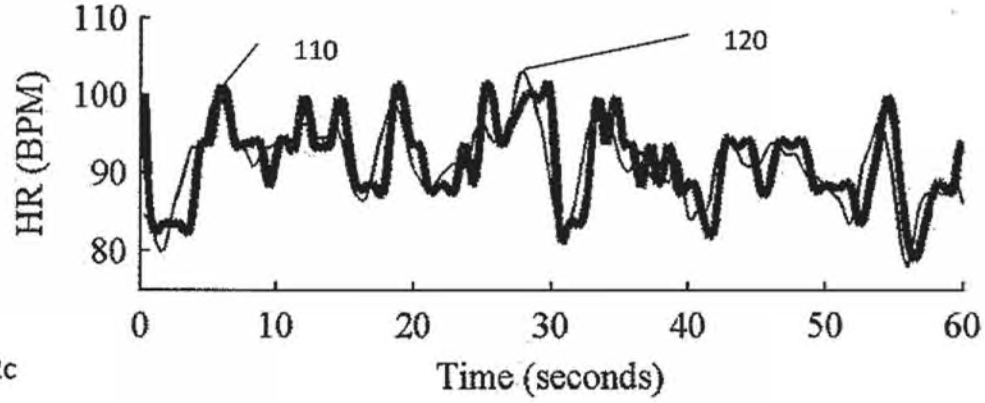
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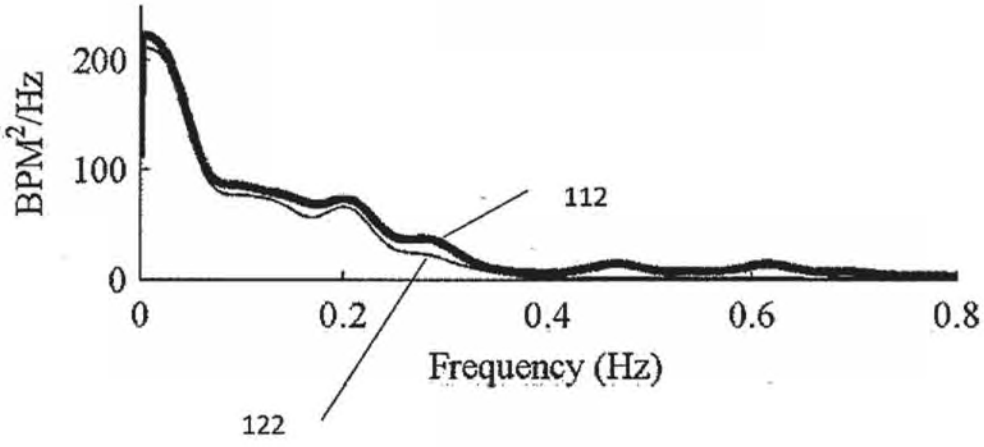
2a



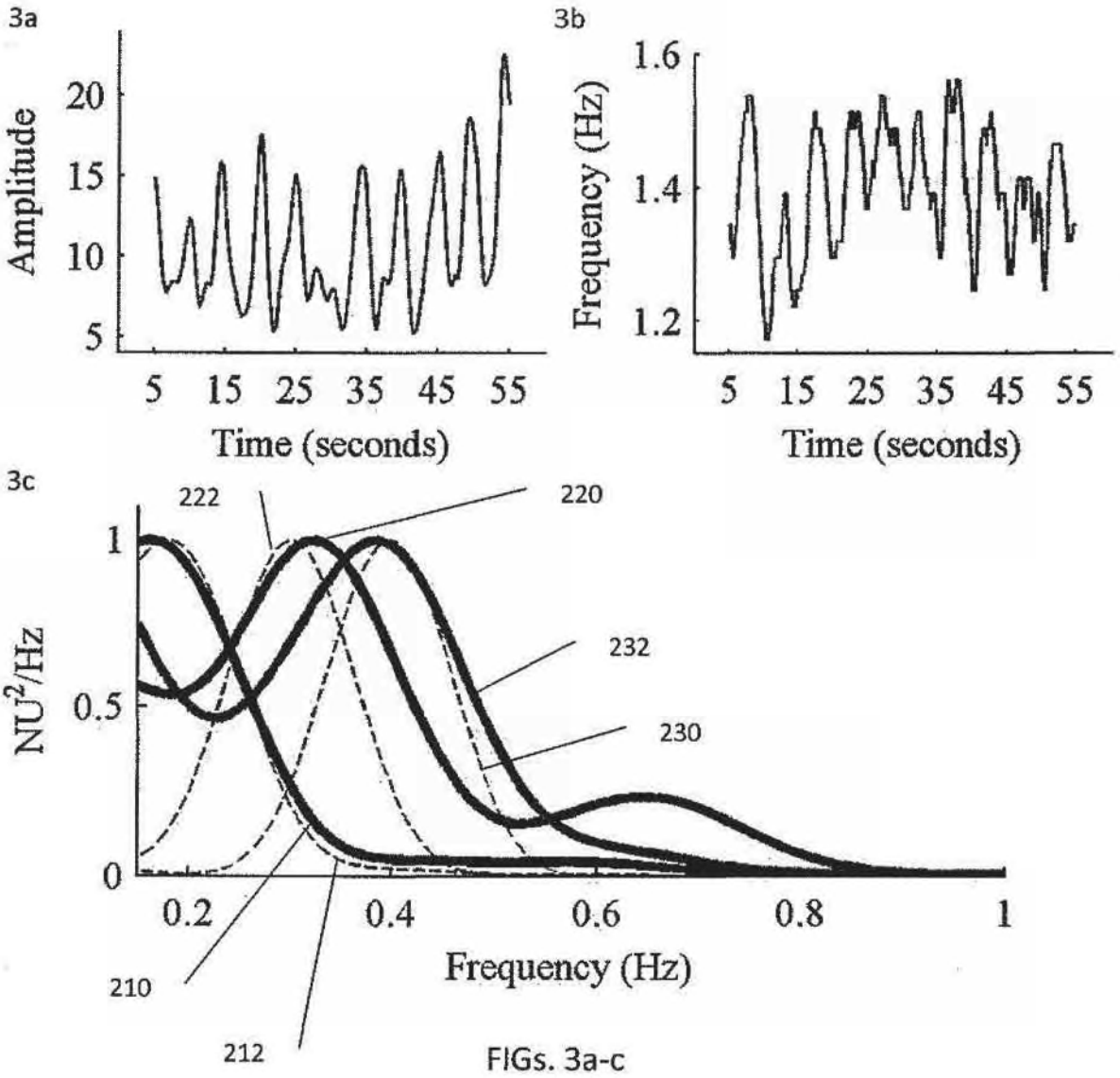
2b



2c

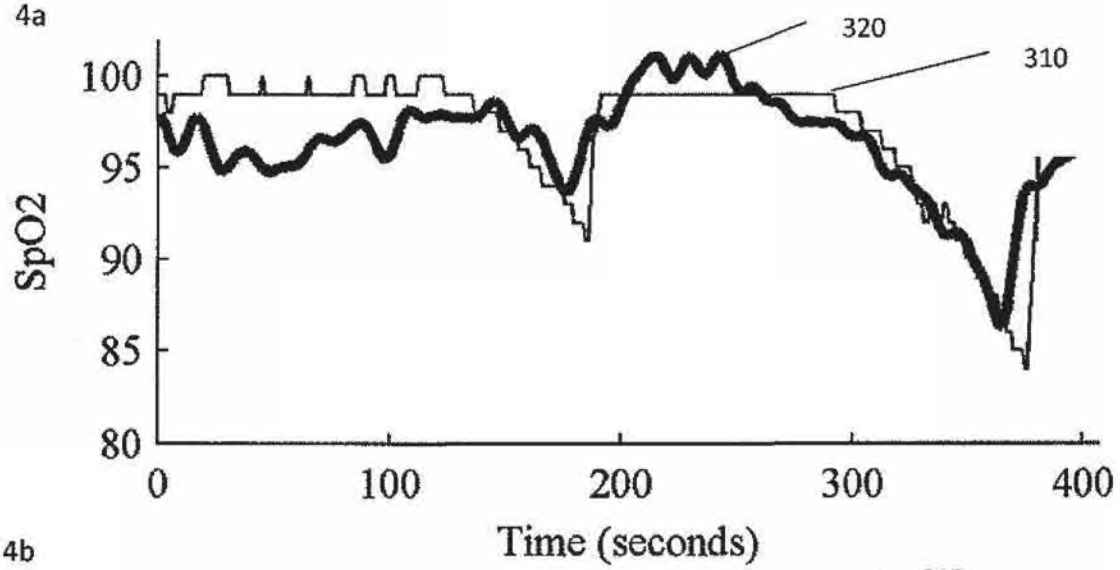


Figs. 2a-c

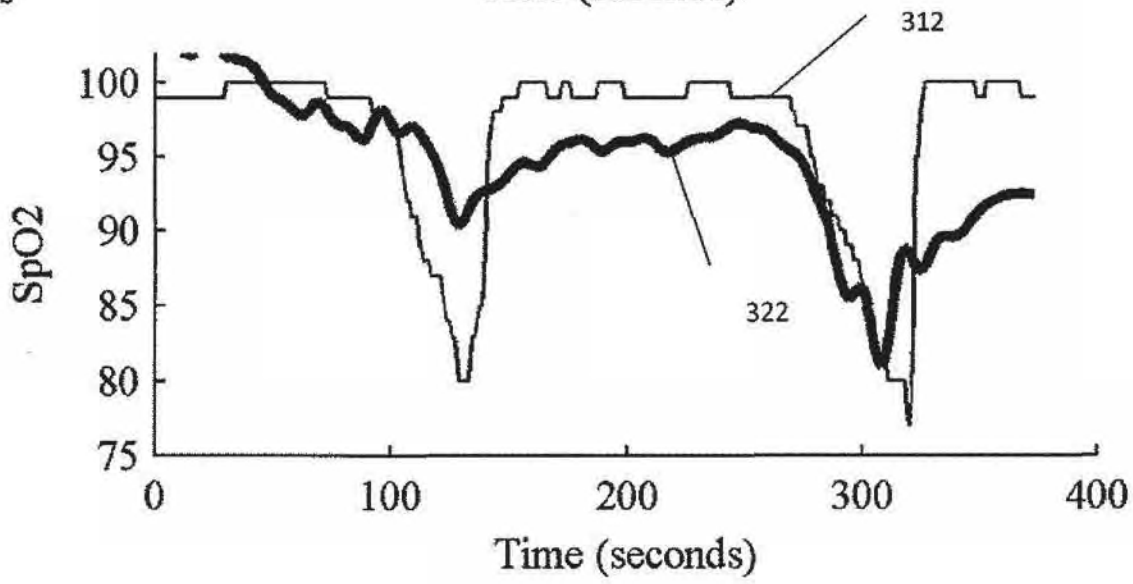

3a
Amplitude
20
15
10
5
5 15 25 35 45 55
Time (seconds)
3b
Frequency (Hz)
1.6
1.4
1.2
5 15 25 35 45 55
Time (seconds)
3c
222
220
232
230
210
212
NU²/Hz
1
0.5
0
0.2 0.4 0.6 0.8 1
Frequency (Hz)

FIGs. 3a-c

4a



4b



Figs. 4a-b

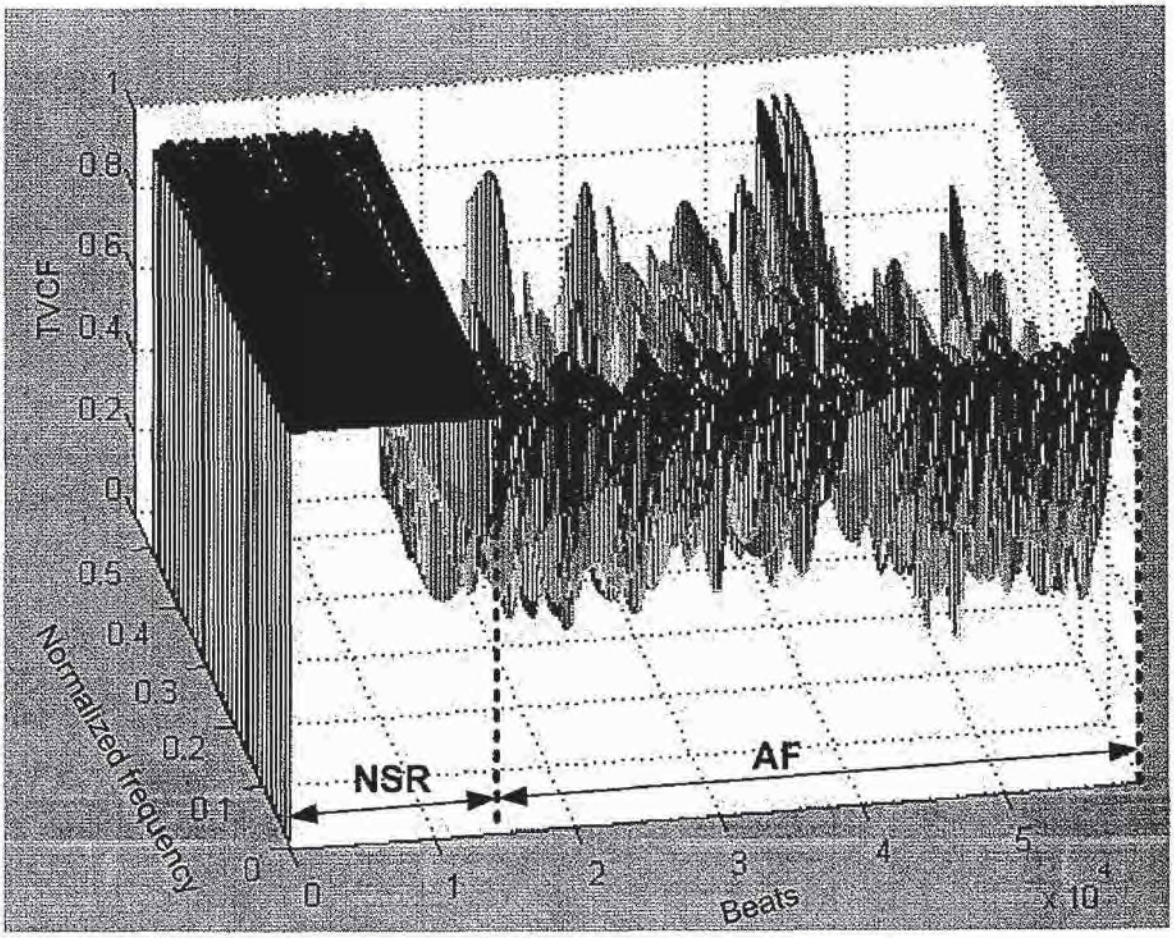

TVCF
1
0.8
0.6
0.4
0.2
0
Normalized frequency
0.5
0.4
0.3
0.2
0.1
0
NSR
AF
0
1
2
3
4
5
Beats
x 10^4

Fig. 5

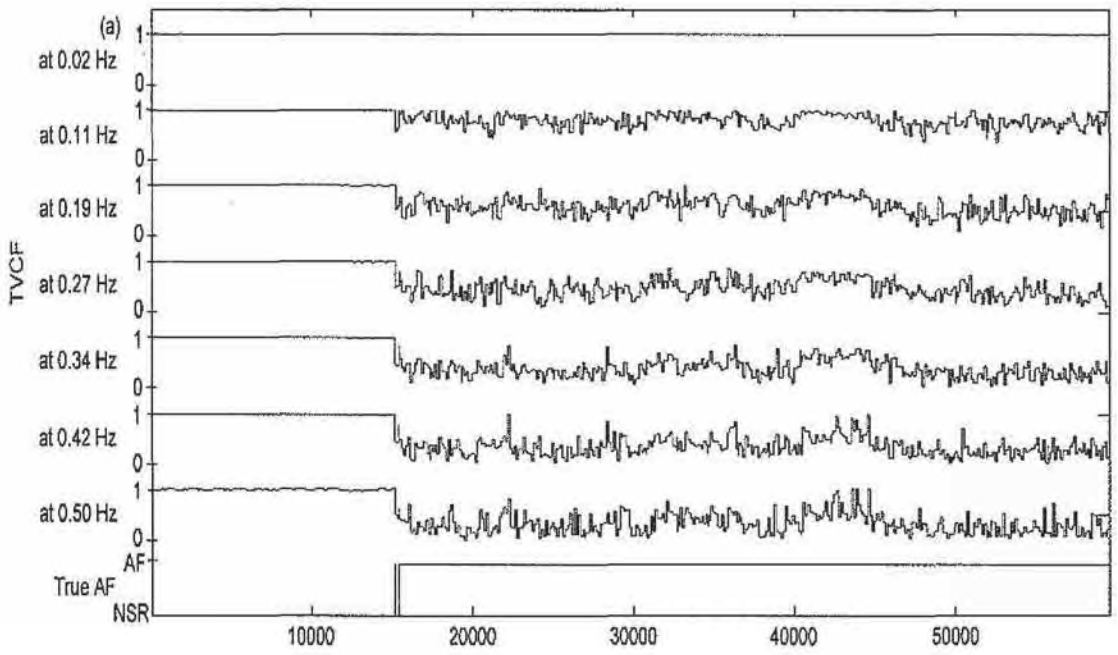


Fig. 6a

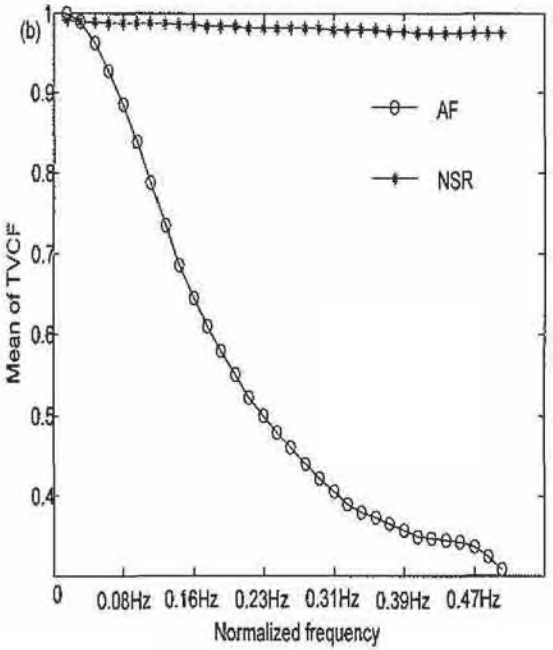
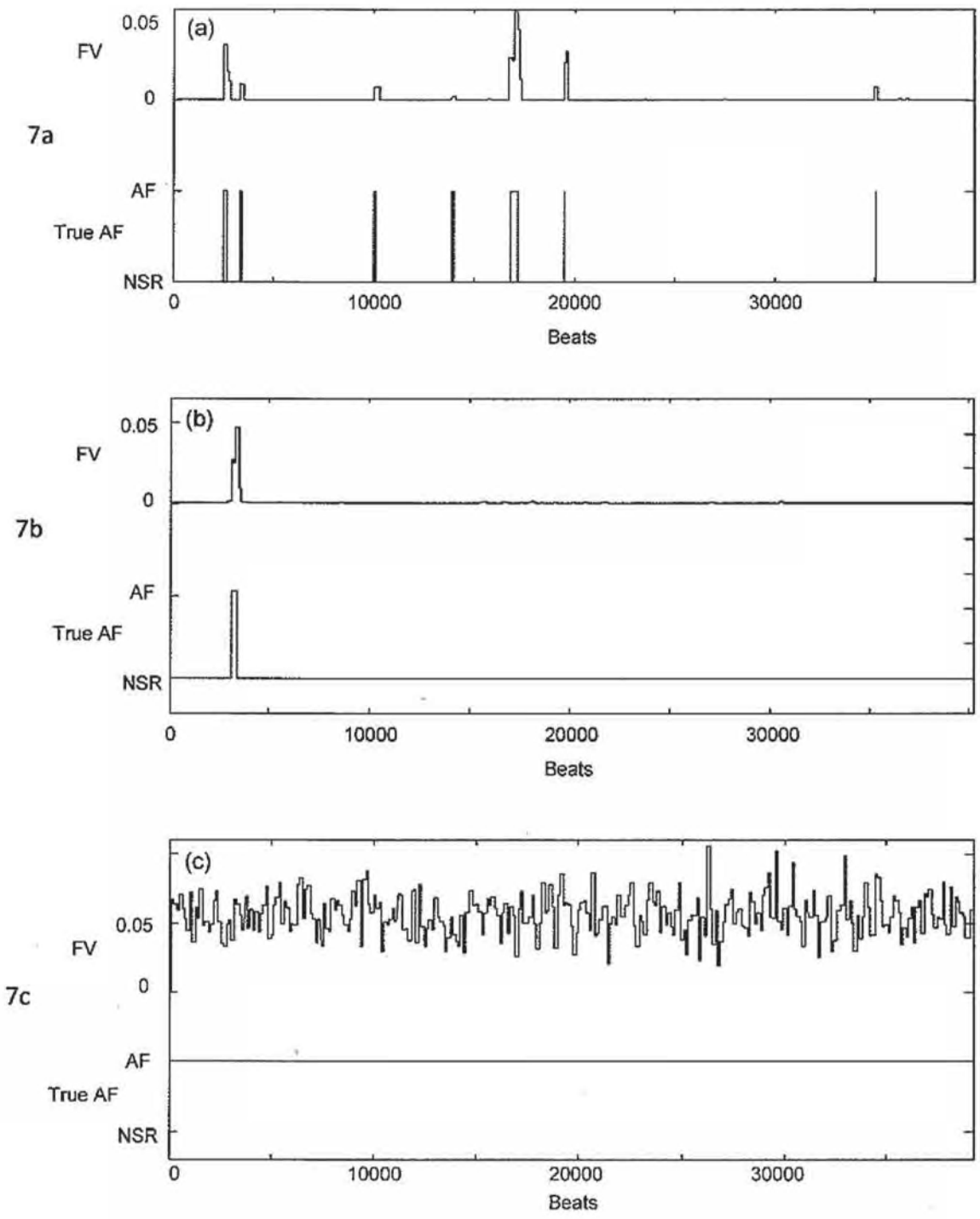


Fig. 6b

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7a
(a)
0.05
FV
0
AF
True AF
NSR
0
10000
20000
30000
Beats
7b
(b)
0.05
FV
0
AF
True AF
NSR
0
10000
20000
30000
Beats
7c
(c)
0.05
FV
0
AF
True AF
NSR
0
10000
20000
30000
Beats

Figs. 7a-c

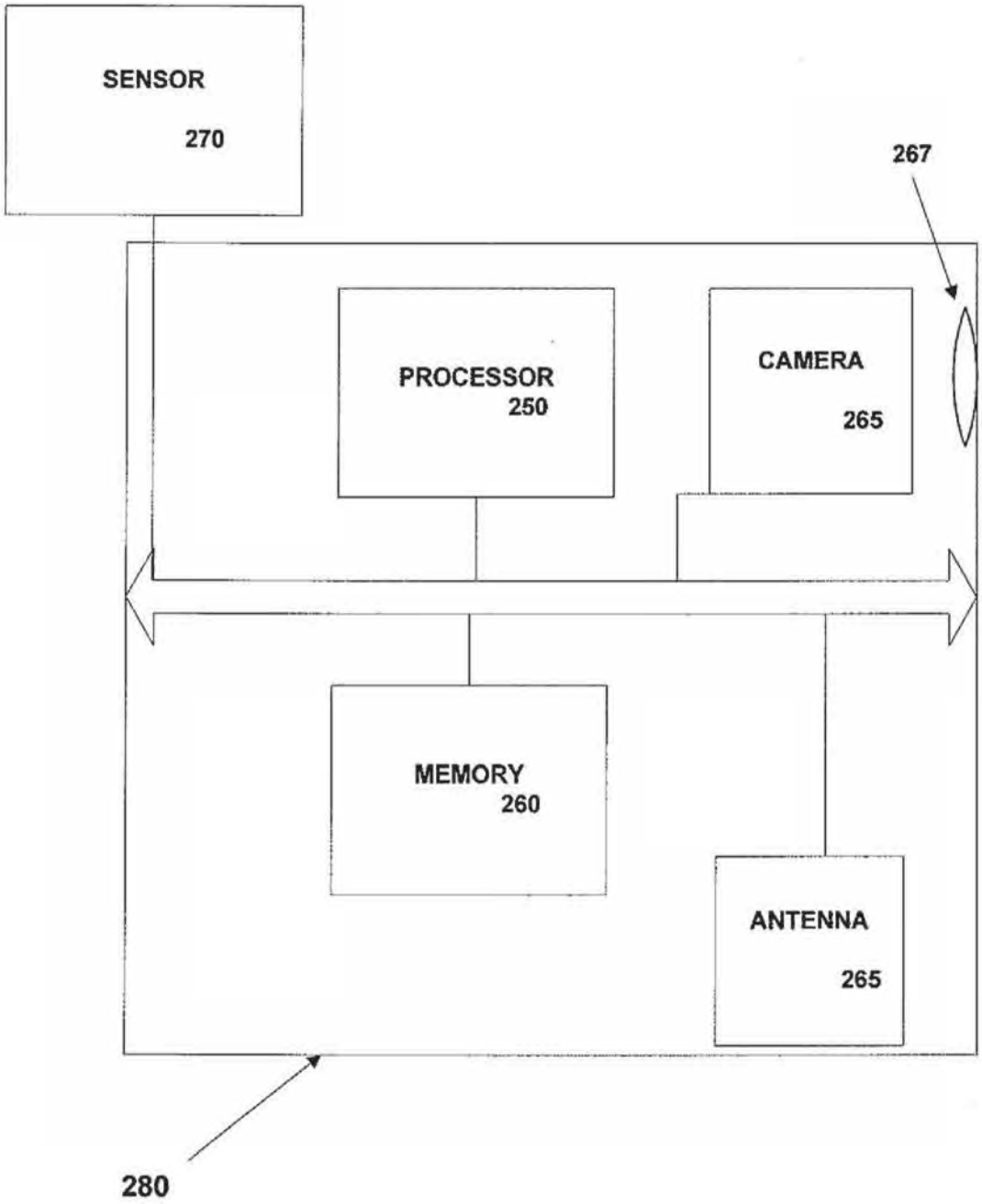

SENSOR
270
267
PROCESSOR
250
CAMERA
265
MEMORY
260
ANTENNA
265
280

Fig. 8

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	30210-201
	Application Number	
Title of Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

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☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ki	H.	Chon	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Worcester	State/Province	MA	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i] US

Mailing Address of Applicant:

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Address 2	100 Institute Road

City	Worcester	State/Province	MA
Postal Code	01609	Country [i]	US

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jinseok		Lee	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Worcester	State/Province	MA	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i] US

Mailing Address of Applicant:

Address 1	c/o Worcester Polytechnic Institute
Address 2	100 Institute Road

City	Worcester	State/Province	MA
Postal Code	01609	Country [i]	US

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Nandakumar		Selvaraj	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Worcester	State/Province	MA	Country of Residence [i]	US

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	Application Number	
Title of Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE	

Citizenship under 37 CFR 1.41(b) [i]	US		
Mailing Address of Applicant:			
Address 1	c/o Worcester Polytechnic Institute		
Address 2	100 Institute Road		
City	Worcester	**State/Province**	MA
Postal Code	01609	**Country**[i]	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

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☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	26486		
Email Address	docketing@burnslev.com	Add Email	Remove Email

Application Information:

Title of the Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE		
Attorney Docket Number	30210-201	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	10	**Suggested Figure for Publication (if any)**	1

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	30210-201
	Application Number	
Title of Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE	

Customer Number	26486

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
Present	non provisional of	61/434862	2011-01-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
Present	non provisional of	61/512199	2011-07-27
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
Present	non provisional of	61/434856	2011-01-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
Present	non provisional of	61/566329	2011-12-02

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

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This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◯ Yes ◯ No

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Assignee 1 Remove

If the Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	30210-201
	Application Number	
Title of Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE	

Mailing Address Information:			
Address 1			
Address 2			
City		**State/Province**	
Country [i]		Postal Code	
Phone Number		Fax Number	
Email Address			
Additional Assignee Data may be generated within this form by selecting the **Add** button.		Add	

Signature:

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Signature	/Orlando Lopez/			Date (YYYY-MM-DD)	2012-01-20
First Name	Orlando	Last Name	Lopez	Registration Number	46880

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Filer:	Marlo M. Schepper
Attorney Docket Number:	30210-201

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	95	95
Utility Search Fee	2111	1	310	310
Utility Examination Fee	2311	1	125	125
Pages:				
Claims:				
Claims in excess of 20	2202	33	30	990
Independent claims in excess of 3	2201	3	125	375
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		1895

Electronic Acknowledgement Receipt

EFS ID:	11886520
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo M. Schepper
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	20-JAN-2012
Filing Date:	
Time Stamp:	15:55:52
Application Type:	Utility under 35 USC 111(a)

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Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1895
RAM confirmation Number	2835
Deposit Account	032410
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Petitioner Ex-1004, 0069

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		01672021.PDF	1645308 1b54885759fe43f705254166f3bb40ddc4a93752	yes	61

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	34
Claims	35	50
Abstract	51	51
Drawings-only black and white line drawings	52	61

Warnings:					
Information:					
2	Application Data Sheet	01671837.PDF	1378269 e9c9f362ac9380ba56a6b329e712c11eae91cf00	no	5
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	38098 3249dae4d0ac3bba7f2b146f72711d6579ad6377	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	3061675		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Acknowledgement Receipt

EFS ID:	11886520
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo M. Schepper
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	20-JAN-2012
Filing Date:	
Time Stamp:	15:55:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1895
RAM confirmation Number	2835
Deposit Account	032410
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Petitioner Ex-1004, 0072

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		01672021.PDF	1645308 1b54885759fe43f705254166f3bb40ddc4a9 3752	yes	61

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Specification	1	34
Claims	35	50
Abstract	51	51
Drawings-only black and white line drawings	52	61

Warnings:

Information:

2	Application Data Sheet	01671837.PDF	1378269 e9c9f362ac9380ba56a6b329e712c11eae91 cf00	no	5

Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	38098 3249dae4d0ac3bba7f2b146f72711d6579a d6377	no	2

Warnings:

Information:

Total Files Size (in bytes):	3061675

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Electronic Acknowledgement Receipt

EFS ID:	11886520
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo M. Schepper
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	20-JAN-2012
Filing Date:	
Time Stamp:	15:55:52
Application Type:	Utility under 35 USC 111(a)

Adjustment date: 02/07/2012 MNGUYEN
01/23/2012 INTEFSW 00002835 032410 13354941
05 FC:2201 375.00 CR

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1895
RAM confirmation Number	2835
Deposit Account	032410
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/354,941

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	95		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	310		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	125		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	53 minus 20 =	* 33	x 30 =	990	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 125 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1520		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/354,941	01/20/2012	1629	1520	30210-201	53	3

CONFIRMATION NO. 9133

26486
BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

FILING RECEIPT

OC000000052514602

Date Mailed: 02/14/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Ki H. Chon, Worcester, MA;
Jinseok Lee, Worcester, MA;
Nandakumar Selvaraj, Worcester, MA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/434,862 01/21/2011
and claims benefit of 61/512,199 07/27/2011
and claims benefit of 61/434,856 01/21/2011
and claims benefit of 61/566,329 12/02/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 02/09/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/354,941**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No
** **SMALL ENTITY** **

Title

PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Preliminary Class

514

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as

set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/354,941	01/20/2012	Ki H. Chon	30210-201

CONFIRMATION NO. 9133

26486
BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

FORMALITIES LETTER

OC000000052514603

Date Mailed: 02/14/2012

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The oath or declaration is missing.
  A properly signed oath or declaration in compliance with 37 CFR 1.63, identifying the application by the above Application Number and Filing Date, is required.
  Note: If a petition under 37 CFR 1.47 is being filed, an oath or declaration in compliance with 37 CFR 1.63 signed by all available joint inventors, or if no inventor is available by a party with sufficient proprietary interest, is required.

The applicant needs to satisfy supplemental fees problems indicated below.

The required item(s) identified below must be timely submitted to avoid abandonment:

- A surcharge (for late submission of filing fee, search fee, examination fee or oath or declaration) as set forth in 37 CFR 1.16(f) of $**65** for a small entity in compliance with 37 CFR 1.27, must be submitted.

SUMMARY OF FEES DUE:

Total fee(s) required within **TWO MONTHS** from the date of this Notice is $**65** for a small entity
- $**65** Surcharge.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/hchin/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Attorney Docket No. 30210-201

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Ki H. Chon et al.
Serial Number: 13/354,941
Filed: January 20, 2012
Title: PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Examiner: TBD
Group Art Unit: TBD
Confirmation No. 9133

Burns & Levinson LLP
125 Summer Street
Boston, MA 02110
(617) 345-3000

To: Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE TO NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

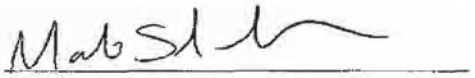
Sir:

In response to the Notice to File Missing Parts dated February 14, 2012, Applicants enclose herewith an executed Declaration/Power of Attorney by the inventors Ki H. Chon, Jinseok Lee and Nandakumar Selvaraj.

The Director of Patents and Trademarks is hereby authorized to charge the small entity late declaration fee, and any deficiencies, or to credit any overpayments, to Deposit Account No. 03-2410, Order No. 30210-201.

Respectfully submitted,
Ki H. Chon et al., Applicants

Dated: April 11, 2012

By: 
Marlo Schepper Grolnic
Reg. No. 57,194
Agent for Applicants

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 13/354,941 filed on January 20, 2012
☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

All statements made herein of my/our knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

POWER OF ATTORNEY

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

PRACTITIONERS ASSOCIATED WITH CUSTOMER NUMBER 26486

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to the address associated with the above-mentioned customer number.

Full Name of Inventor(s)

Inventor One: Ki H. Chon **Citizen of:** US
Signature: K. H. Chon **Date:** 4/6/12

Inventor Two: Jinseok Lee **Citizen of:** US
Signature: _____ **Date:** 4/6/12

Inventor Three: Nandakumar Selvaraj **Citizen of:** US
Signature: _____ **Date:** _____

Petitioner Ex-1004, 0083

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 13/354,941 filed on January 20, 2012
☐ As amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

All statements made herein of my/our knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

POWER OF ATTORNEY

I hereby revoke all previous powers of attorney given in the above-identified application.

I hereby appoint:

PRACTITIONERS ASSOCIATED WITH CUSTOMER NUMBER 26486

as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith.

Please recognize or change the correspondence address for the above-identified application to the address associated with the above-mentioned customer number.

Full Name of Inventor(s)

Inventor One: Ki H. Chon **Citizen of:** US
Signature: _____ **Date:** _____

Inventor Two: Jinseok Lee **Citizen of:** US
Signature: _____ **Date:** _____

Inventor Three: Nandakumar Selvaraj **Citizen of:** US
Signature: _____ **Date:** 04/06/2012

01675895.DOC\

Electronic Patent Application Fee Transmittal

Application Number:	13354941
Filing Date:	20-Jan-2012
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Filer:	Marlo M. Schepper
Attorney Docket Number:	30210-201

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Late filing fee for oath or declaration	2051	1	65	65
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**65**

Electronic Acknowledgement Receipt

EFS ID:	12513738
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo M. Schepper
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	11-APR-2012
Filing Date:	20-JAN-2012
Time Stamp:	09:57:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$65
RAM confirmation Number	7689
Deposit Account	032410
Authorized User	

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Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

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Petitioner Ex-1004, 0087

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		01702089.PDF	107196 0fba56a439446d9d30c1f4a86b7a4b63ada35fd9	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Applicant Response to Pre-Exam Formalities Notice	1	1
	Oath or Declaration filed	2	3

Warnings:

Information:

2	Fee Worksheet (SB06)	fee-info.pdf	30346 fa8237e34ff2cc58611767c79fd659187cdc6008	no	2

Warnings:

Information:

Total Files Size (in bytes):	137542

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/354,941

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	95		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	310		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	125		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	53 minus 20 =	* 33	x 30 =	990	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 125 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1520		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/354,941	01/20/2012	1629	1585	30210-201	53	3

CONFIRMATION NO. 9133

UPDATED FILING RECEIPT

26486
BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110



Date Mailed: 04/19/2012

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Ki H. Chon, Worcester, MA;
Jinseok Lee, Worcester, MA;
Nandakumar Selvaraj, Worcester, MA;

Power of Attorney: The patent practitioners associated with Customer Number 26486

Domestic Priority data as claimed by applicant

This appln claims benefit of 61/434,862 01/21/2011
and claims benefit of 61/512,199 07/27/2011
and claims benefit of 61/434,856 01/21/2011
and claims benefit of 61/566,329 12/02/2011

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 02/09/2012

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/354,941**

Projected Publication Date: 07/26/2012

Non-Publication Request: No

Early Publication Request: No
** **SMALL ENTITY** **

Title

PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Preliminary Class

514

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/354,941	01/20/2012	Ki H. Chon	30210-201

CONFIRMATION NO. 9133

26486
BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

PUBLICATION NOTICE



Title:PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Publication No.US-2012-0190947-A1
Publication Date:07/26/2012

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

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PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13354941
Filing Date	2012-01-20
First Named Inventor	Ki H. Chon et al.
Art Unit	1629
Examiner Name	TBD
Attorney Docket Number	30210-201 (US)

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7254425	B2	2007-08-07	Michael G. Lowery et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20060135860	A1	2006-06-22	Clark Baker et al.	
	2	20070078316	A1	2007-04-05	Hoarau Carine et al.	
	3	20100030088	A1	2010-02-04	Carney James Kevin et al.	

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	1							☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13354941
	Filing Date	2012-01-20
	First Named Inventor	Ki H. Chon et al.
	Art Unit	1629
	Examiner Name	TBD
	Attorney Docket Number	30210-201 (US)

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report dated June 28, 2012 from co-pending PCT/US2012/022049, filed on January 20, 2012, which claims the benefit of U.S. Provisional Application Serial No. 61/434,856, filed on January 21, 2011.	☐
	2	Written Opinion from the International Searching Authority from co-pending PCT/US2012/022049, filed on January 20, 2012, which claims the benefit of U.S. Provisional Application Serial No. 61/434,856, filed on January 21, 2011.	☐

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13354941
	Filing Date	2012-01-20
	First Named Inventor	Ki H. Chon et al.
	Art Unit	1629
	Examiner Name	TBD
	Attorney Docket Number	30210-201 (US)

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Orlando Lopez/	Date (YYYY-MM-DD)	2012-09-10
Name/Print	Orlando Lopez	Registration Number	46880

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Acknowledgement Receipt

EFS ID:	13695365
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo Schepper Grolnic
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	10-SEP-2012
Filing Date:	20-JAN-2012
Time Stamp:	11:44:45
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		201SpIDS.pdf	448567 d4746a1da6c5a49338b354cffb613b50f578 02a1	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Transmittal Letter	1	1
	Other Reference-Patent or Application Document	2	4
	Other Reference-Patent or Application Document	5	8

Warnings:					
Information:					
2	Information Disclosure Statement (IDS) Form (SB08)	201IDSxx.pdf	612661 6d3d5b3904f1420df398bf8b9179798cef19ddce	no	4
Warnings:					
Information:					
		Total Files Size (in bytes):	1061228		

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Ki H. Chon et al.
U.S. Pat. Appl. Ser. No.: 13/354,941
Filing Date: January 20, 2012
Confirmation No.: 9133
Applicant/Owner: Worcester Polytechnic Institute
Group Art Unit: 1629
Priority Date: January 21, 2011
Examiner: Not Yet Assigned
Entitled: PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Burns & Levinson LLP
125 Summer Street
Boston, MA 02110
(617) 345-3000

To: Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

Dear Sir/Madam:

This Information Disclosure Statement (Form PTO/SB/08a) (including copies of non-patent literature) is submitted under 37 CFR 1.97(b)(3), before the mailing of a first office action on the merits.

In view thereof, no fee is required. However, in the event fees are required, please charge any underpayment of fees or credit any overpayment of fees to Deposit Account No. 03-2410, Attorney Docket No.: 30210-201 US.

The following information is presented in the event that a call may be deemed desirable by the Examiner:

DR. ORLANDO LOPEZ, ESQ. (617) 345-3243

Respectfully submitted,
Worcester Polytechnic Institute/Applicant

Dated: ~~August~~ Sept. 10, 2012

By: _____

Dr. Orlando Lopez, Esq.
Reg. No.: 46,880
Attorney for Applicant

Petitioner Ex-1004, 0100

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
30210-201PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2012/022049	20 JANUARY 2012 (20.01.2012)	21 JANUARY 2011 (21.01.2011)

Applicant

WORCESTER POLYTECHNIC INSTITUTE et al

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the international Bureau.

This international search report consists of a total of 3 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed
      ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. ☐ **Certain claims were found unsearchable** (See Box No. II)
3. ☐ **Unity of invention is lacking** (See Box No. III)
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.
6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figure is to be published with the abstract.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/022849

A. CLASSIFICATION OF SUBJECT MATTER

A61B 5/02(2006.01)i, A61B 5/0452(2006.01)i, A61B 5/1455(2006.01)i, H04B 7/24(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B 5/02; A61B 5/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: physiological, sensor, motion artifact, discard

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ✓	US 2010-0030088 A1 (CARNEY JAMES KEVIN et al.) 04 February 2010 See abstract, paragraphs [0028]-[0049],[0106]-[0121], claims 1-22,	24,44
Y	and figures 1,8-10.	1
A		2-23,25-43,45-53
X ✓	US 2006-0135860 A1 (CLARK BAKER et al.) 22 June 2006 See abstract, paragraphs [0021]-[0028],[0043],[0057]-[0059], claims 1-28,	44
Y	and figures 1,2.	1
X ✓	US 2007-0078316 A1 (HOARAU CARINE et al.) 05 April 2007 See abstract, paragraphs [0047]-[0052], claims 47,48, and figures 7-9.	44
X ✓	US 7254425 B2 ((MICHAEL G. LOWERY et al.) 07 August 2007 See abstract, column 4, lines 51-67, and claims 1-12.	44

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 JUNE 2012 (27.06.2012)	**28 JUNE 2012 (28.06.2012)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	KIM Tae Hoon Telephone No. 82-42-481-5728

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/US2012/022049

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010-0030088 A1	04.02.2010	EP 2346394 A1	27.07.2011
		WO 2010-014415 A1	04.02.2010
US 2006-0135860 A1	22.06.2006	CA 2512401 A1	29.07.2004
		EP 1587416 A1	26.10.2005
		JP 2006-512973 A	20.04.2006
		JP 2006-512973 T	20.04.2006
		US 2004-0138540 A1	15.07.2004
		US 7006856 B2	28.02.2006
		US 8095192 B2	10.01.2012
		WO 2004-062492 A1	29.07.2004
US 2007-0078316 A1	05.04.2007	US 2009-0118598 A1	07.05.2009
		US 7483731 B2	27.01.2009
		WO 2007-041330 A1	12.04.2007
US 7254425 B2	07.08.2007	CA 2553686 A1	18.08.2005
		EP 1706021 A1	04.10.2006
		US 2005-0165316 A1	28.07.2005
		WO 2005-074811 A1	18.08.2005

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
LOPEZ ORLANDO

BURNS & LEVINSON, LLP 125 SUMMER STREET
BOSTON MA 02110 USA

PCT

✓ WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

gr 7.12.12

Date of mailing *(day/month/year)*	28 JUNE 2012 (28.06.2012)
Applicant's or agent's file reference 30210-201PCT	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2012/022049	20 JANUARY 2012 (20.01.2012)	21 JANUARY 2011 (21.01.2011)

International Patent Classification (IPC) or both national classification and IPC

A61B 5/02(2006.01)i, A61B 5/0452(2006.01)i, A61B 5/1455(2006.01)i, H04B 7/24(2006.01)i

Applicant

WORCESTER POLYTECHNIC INSTITUTE et al

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.
For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/KR	Date of completion of this opinion	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. 82-42-472-7140	27 JUNE 2012 (27.06.2012)	KIM Tae Hoon Telephone No. 82-42-481-5728

Form PCT/ISA/237 (cover sheet) (July 2011)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/022049

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. a sequence listing filed or furnished
      ☐ on paper
      ☐ in electronic form

   b. time of filing or furnishing
      ☐ contained in the international application as filed.
      ☐ filed together with the international application in electronic form.
      ☐ furnished subsequently to this Authority for the purposes of search.

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2012/022049

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-23,25-43,45-53	YES
	Claims	24,44	NO
Inventive step (IS)	Claims	2-23,25-43,45-53	YES
	Claims	1,24,44	NO
Industrial applicability (IA)	Claims	1-53	YES
	Claims	NONE	NO

2. Citations and explanations :

Reference is made to the following documents:

D1: US 2010-0030088 A1 (CARNEY JAMES KEVIN et al.) 04 February 2010
D2: US 2006-0135860 A1 (CLARK BAKER et al.) 22 June 2006
D3: US 2007-0078316 A1 (HOARAU CARINE et al.) 05 April 2007
D4: US 7254425 B2 ((MICHAEL G. LOWERY et al.) 07 August 2007

2.1 Novelty and Inventive Step

2.1.1 Claim 1

D1, which is considered to be the closest prior art to the subject matter of claim 1, discloses monitoring one or more physiological parameters of patient, detecting an arterial pulse of the patient based on at least one of the first or second electrical signals from the IMD, and determining whether a detected pulse is a true arterial pulse or a spurious pulse. Claim 1 differs from D1 in deciding whether to retain the measurements. However, D2 discloses that the measured physiological value is sent to be displayed by the device's monitor, if the value is at least equal to the threshold. Accordingly, claim 1 would have been obvious over D1 in view of D2. Therefore, claim 1 lacks an inventive step under PCT Article 33(3).

2.1.2 Claims 2-23

The additional features of claims 2-23 which are dependent on claim 1, are not disclosed in any of the prior art documents, nor are they obvious to a person skilled in the art by the documents. Accordingly, claims 2-23 are novel and involve an inventive step under PCT Article 33(2) and 33(3).

2.1.3 Claim 24

D1, which is considered to represent the most relevant state of the art, discloses an implanted medical device to monitor one or more physiological parameters of patient, an IMD communicating with external device, and a processor of external device receiving signals from optical sensors and determine whether a detected pulse is a true arterial pulse or a spurious pulse, wherein the implanted device detects an arterial pulse of the patient and motion artifacts cause optical sensors to generate signals indicating spurious pulse. As all of the features of claim 24 are disclosed in D1, this claim is anticipated by D1. Therefore, claim 24 lacks novelty under PCT Article 33(2).

2.1.4 Claims 25-43

The additional features of claims 25-43 which are dependent on claim 24, are not disclosed in any of the prior art documents, nor are they obvious to a person skilled in the art by the documents. Accordingly, claims 25-43 are novel and involve an inventive step under PCT Article 33(2) and 33(3).

Continued on Supplemental Box

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Box V

2.1.5 Claim 44
D1, which is considered to represent the most relevant state of the art, discloses an implanted medical device to detect an arterial pulse of the patient based on at least one of the first or second electrical signals from the IMD and a processor of external device receiving signals from optical sensors and determine whether a detected pulse is a true arterial pulse or a spurious pulse. As all of the features of claim 44 are disclosed in D1, this claim is anticipated by D1. D2-D4 also disclose all of the features of claim 44. Therefore, claim 44 lacks novelty under PCT Article 33(2).

2.1.6 Claims 45-53
The additional features of claims 45-53 which are dependent on claim 44, are not disclosed in any of the prior art documents, nor are they obvious to a person skilled in the art by the documents. Accordingly, claims 45-53 are novel and involve an inventive step under PCT Article 33(2) and 33(3).

2.2 Industrial Applicability
Claims 1-53 are industrially applicable under PCT Article 33(4).

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/354,941	01/20/2012	Ki H. Chon	30210-201	9133

26486 7590 09/11/2013

BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

EXAMINER	
LIU, CHU CHUAN	

ART UNIT	PAPER NUMBER
3777	

NOTIFICATION DATE	DELIVERY MODE
09/11/2013	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@burnslev.com

Office Action Summary	Application No. 13/354,941	Applicant(s) CHON ET AL.	
	Examiner CHU CHUAN (JJ) LIU	Art Unit 3777	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 1 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01/20/2012*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-53* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☐ Claim(s) _____ is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☒ Claim(s) *1-53* are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

4) ☐ Other: _____.

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Petitioner Ex-1004, 0109

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

Election/Restrictions

2. Claim(s) 1, 24 and 44 are generic to the following disclosed patentably distinct species: physiological measurements of image/ video image; PPG; electrocardiogram; heart rate; respiratory; oxygen saturation; blood loss; and atrial fibrillation. The species are independent or distinct because as disclosed the different species have mutually exclusive characteristics for each identified species. In addition, these species are not obvious variants of each other based on the current record.

Applicant is required under 35 U.S.C. 121 to elect a single disclosed species, or a single grouping of patentably indistinct species, for prosecution on the merits to which the claims shall be restricted if no generic claim is finally held to be allowable.

There is a search and/or examination burden for the patentably distinct species as set forth above because at least the following reason(s) apply:

- *the species or groupings of patentably indistinct species have acquired a separate status in the art in view of their different classification*
- *the species or groupings of patentably indistinct species have acquired a separate status in the art due to their recognized divergent subject matter*
- *the species or groupings of patentably indistinct species require a different field of search (e.g., searching different classes/subclasses or electronic resources, or employing different search strategies or search queries).*

Applicant is advised that the reply to this requirement to be complete must include (i) an election of a species or a grouping of patentably indistinct species

to be examined even though the requirement may be traversed (37 CFR 1.143) **and (ii) identification of the claims encompassing the elected species** or grouping of patentably indistinct species, including any claims subsequently added. An argument that a claim is allowable or that all claims are generic is considered nonresponsive unless accompanied by an election.

The election may be made with or without traverse. To preserve a right to petition, the election must be made with traverse. If the reply does not distinctly and specifically point out supposed errors in the election of species requirement, the election shall be treated as an election without traverse. Traversal must be presented at the time of election in order to be considered timely. Failure to timely traverse the requirement will result in the loss of right to petition under 37 CFR 1.144. If claims are added after the election, applicant must indicate which of these claims are readable on the elected species or grouping of patentably indistinct species.

Should applicant traverse on the ground that the species, or groupings of patentably indistinct species from which election is required, are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the species unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103 or pre-AIA 35 U.S.C. 103(a) of the other species.

Upon the allowance of a generic claim, applicant will be entitled to consideration of claims to additional species which depend from or otherwise require all the limitations of an allowable generic claim as provided by 37 CFR 1.141.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHU CHUAN (JJ) LIU whose telephone number is (571)270-5507. The examiner can normally be reached on M-TH 7:00am~3:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tse Chen can be reached on (571)272-3672. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Chu Chuan Liu/
Examiner, Art Unit 3777

/Tse Chen/
Supervisory Patent Examiner, Art Unit 3777

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon et al.
Serial Number: 13/354,941
Filed: 01-20-2012
Title: PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Examiner: LIU, CHU CHUAN
Group Art Unit: 3777
Confirmation No. 9133

BURNS & LEVINSON, LLP
125 Summer St.
Boston, MA 02110
(617) 345-3243

TO: Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450,
Alexandria, VA 22313-1450

AMENDMENT AND RESPONSE TO RESTRICTION REQUIREMENT

Sir:

In response to a requirement for restriction under 35 U.S.C. 121 dated September 11, 2013, Applicants traverse the rejection but make the following provisional election of the atrial fibrillation species, Claims 1-9, 18-23, 24-34, 39-43, 44 and 49-53.

Amendments to the Claims begin on page 2 of this paper.

Remarks begin on page 16 of this paper.

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of the claims.

1. (Original) A method for physiological parameter monitoring, the method comprising:
providing a physiological indicator signal to a mobile communication device;

analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters; and

detecting, using the mobile communications device, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements.

2. (Original) The method of claim 1 wherein the step of detecting effects of motion artifacts in the measurements comprises:
   a. preprocessing a segment from the measurement of one physiological parameter;
   b. obtaining a value of at least one indicator of volatility for the preprocessed segment;
   c. including the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present; and
   d. selecting another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available.

3. (Original) The method of claim 2 wherein said at least one indicator of volatility comprises kurtosis.

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4. (Original) The method of claim 2 wherein said at least one indicator of volatility comprises Shannon entropy.

5. (Original) The method of claim 2 wherein said at least one measure of volatility comprises kurtosis and Shannon entropy.

6. (Original) The method of claim 2 wherein the predetermined threshold is determined using receiver operator characteristic (ROC) analysis.

7. (Original) The method of claim 1 wherein providing a physiological indicator signal comprises:
placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and

obtaining video images of the portion of the subject's body.

8. (Original) The method of claim 1 wherein providing a physiological indicator signal comprises obtaining a signal from a physiological monitoring sensor.

9. (Original) The method of claim 8 wherein the physiological monitoring sensor is a photoplethysmographic (PPG) sensor or an electrocardiogram sensor.

10. (Original) The method of claim 1 wherein the one or more physiological measurements comprise heart rate and heart rate variability.

11. (Original) The method of claim 10 wherein obtaining measurements of heart rate and heart rate variability comprise:
determining beats for the physiological indicator signal;

determining beat to beat intervals; and

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applying a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

12. (Original) The method of claim 1 wherein the one or more physiological measurements comprise respiratory rate.

13. (Original) The method of claim 12 wherein measurement of respiratory rate comprises:
obtaining time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtaining respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

14. (Original) The method of claim 1 wherein the one or more physiological measurements comprise a measure of oxygen saturation.

15. (Original) The method of claim 14 wherein providing a physiological indicator signal comprises:
placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and

obtaining video images of the portion of the subject's body, and

wherein obtaining the measure of oxygen saturation comprises:
obtaining an average intensity of a red component and a blue component of the video images of the portion of the subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

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obtaining a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtaining the measure of oxygen saturation (SpO2) by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

16. (Original) The method of claim 1 wherein the one or more physiological measurements comprise a measure of blood loss.

17. (Original) The method of claim 16 wherein obtaining the measure of blood loss comprises:
obtaining time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtaining the amplitude modulation (AM) series from a set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time–frequency spectrum; and

determining whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

18. (Original) The method of claim 1 wherein the one or more physiological measurements comprise a measure of atrial fibrillation.

19. (Original) The method of claim 18 wherein obtaining the measure of atrial fibrillation comprises:

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obtaining a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determining whether the time-varying coherence function is less than a predetermined quantity.

20. (Original) The method of claim 19 wherein determining whether the time-varying coherence function is less than the predetermined quantity comprises:
obtaining one or more indicators of atrial fibrillation; and

determining whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

21. (Original) The method of claim 20 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

22. (Original) The method of claim 21 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

23. (Original) The method of claim 20 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

24. (Original) A system for physiological parameter monitoring, the system comprising:
a physiological indicator signal sensing component; and a mobile communication device comprising:

an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters; and

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a motion artifact detection component detecting effects of motion artifacts in the measurements of the one or more physiological parameters.

25. (Original) The system of claim 24 wherein the mobile communications device comprises: at least one processor; and

at least one computer usable medium, the computer usable medium having computer readable code embodied therein, the computer readable code causing the at least one processor to:

analyze the physiological indicator signal to obtain measurements of one or more physiological parameters; and

detect effects of motion artifacts in the measurements of the one or more physiological parameters.

26. (Original) The system of claim 25 wherein the computer readable code, in causing the at least one processor to detect effects of motion artifacts, causes the at least one processor to:

a. preprocess a segment from the measurement of one physiological parameter;
b. obtain a value of at least one indicator of volatility for the preprocessed segment;
c. include the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present;
d. select another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available.

27. (Original) The system of claim 26 wherein said at least one indicator of volatility comprises kurtosis.

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28. (Original) The system of claim 26 wherein said at least one indicator of volatility comprises Shannon entropy.

29. (Original) The system of claim 26 wherein said at least one measure of volatility comprises kurtosis and Shannon entropy.

30. (Original) The system of claim 26 wherein the predetermined threshold is determined using receiver operator characteristic (ROC) analysis.

31. (Original) The system of claim 24 wherein the physiological indicator signal sensing component comprises an image acquisition component, said acquisition component capable of acquiring a number of frames, each frame acquired at a predetermined time.

32. (Original) The system of claim 31 wherein the mobile communications device comprises said image acquisition component.

33. (Original) The system of claim 24 wherein the physiological indicator signal sensing component comprises a physiological monitoring sensor.

34. (Original) The system of claim 33 wherein the physiological monitoring sensor is a photoplethysmographic (PPG) sensor or an electrocardiogram sensor.

35. (Original) The system of claim 25 wherein the physiological indicator signal sensing component comprises an image acquisition component, said acquisition component capable of acquiring a number of frames, each frame acquired at a predetermined time; wherein said image acquisition component acquires a color image having red, green and blue components; wherein one or more physiological measurements comprise a measure of oxygen saturation; and wherein the computer readable code, in causing the at least one

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processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain an average intensity of a red component and a blue component of the images of a portion of a subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtain a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtain the measure of oxygen saturation by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

36. (Original) The system of claim 25 wherein the one or more physiological measurements comprise heart rate and heart rate variability; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

determine beats for the physiological indicator signal;
determine beat to beat intervals; and

apply a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

37. (Original) The system of claim 25 wherein the one or more physiological measurements comprise respiratory rate; and wherein the computer readable code, in causing the at least

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one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtain respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

38. (Original) The system of claim 25 wherein the one or more physiological measurements comprise a measure of blood loss; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtain the amplitude modulation (AM) series from set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time–frequency spectrum; and

determine whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

39. (Original) The system of claim 25 wherein the one or more physiological measurements comprise a measure of atrial fibrillation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

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obtain a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determine whether the time-varying coherence function is less than a predetermined quantity.

40. (Original) The system of claim 39 wherein the computer readable code, in causing the at least one processor to determine whether the time-varying coherence function is less than the predetermined quantity, causes the at least one processor to:

obtain one or more indicators of atrial fibrillation; and
determine whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

41. (Original) The system of claim 40 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

42. (Original) The system of claim 41 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

43. (Original) The system of claim 41 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

44. (Original) A computer usable medium having computer readable code embodied therein, the computer readable code causing at least one processor to:

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analyze a physiological indicator signal to obtain measurements of one or more physiological parameters; and

detect effects of motion artifacts in the measurements of the one or more physiological parameters.

45. (Original) The computer usable medium of claim 44 wherein the physiological indicator signal comprises a video color image having red, green and blue components, the video color image being an image obtained from of a portion of a subject's body; wherein the measurements of one or more physiological parameters comprise a measure of oxygen saturation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain an average intensity of the red component and a blue component of the video color image of a portion of a subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtain a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtain the measure of oxygen saturation by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}},$$

46. (Original) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise heart rate and heart rate variability; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

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determine beats for the physiological indicator signal;

determine beat to beat intervals; and

apply a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

47. (Original) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise respiratory rate; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtain respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

48. (Original) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise a measure of blood loss; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:
obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtain the amplitude modulation (AM) series from set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time–frequency spectrum; and

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determine whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

49. (Original) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise a measure of atrial fibrillation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determine whether the time-varying coherence function is less than a predetermined quantity.

50. (Original) The computer usable medium of claim 44 wherein the computer readable code, in causing the at least one processor to determine whether the time-varying coherence function is less than the predetermined quantity, causes the at least one processor to:

obtain one or more indicators of atrial fibrillation;
determine whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

51. (Original) The computer usable medium of claim 50 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

52. (Original) The computer usable medium of claim 51 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

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53. (Original) The computer usable medium of claim 50 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

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REMARKS

Applicants have carefully reviewed the Office Action dated September 11, 2013, and this response addresses the Examiner's concerns.

I. STATUS OF THE CLAIMS

Claims 1-53 are pending.

Claims 1-53 were subject to an election/restriction requirement.

II. THE RESTRICTION REQUIREMENT

In the Office Action, the Examiner restricts the claims as follows:

The Examiner finds that claims 1, 24 and 44 are generic and has asked the Applicants to select a species from physiological measurements of image/video image; PPG; electrocardiogram; heart rate; respiratory; oxygen saturation; blood loss; and atrial fibrillation.

Applicant respectfully traverses the Restriction Requirement for the reasons given below. (Since the restriction requirement is being traversed, the listing of the claims follows the nomenclature for amended claims and no claims are listed as withdrawn.) However, as required under 37 CFR 1.143, to complete the response, Applicant provisionally elects the atrial fibrillation species, Claims 1-9, 18-23, 24-34, 39-43, 44 and 49-53.

The Examiner states that the species are independent or distinct because as disclosed the different species have mutually exclusive characteristics for each identified species. The first two species, physiological measurements of image/video image measure of images and PPG, are generic. Both physiological measurements of image/video image measure of images and PPG are methods for providing a physiological indicator signal and PPG is one of two exemplary methods recited in the claim. **(Choosing PPG as a species would require splitting a claim limitation in half.)** Since the physiological indicators signal for all of the physiological measurements, electrocardiogram; heart rate; respiratory; oxygen saturation; blood loss; and atrial fibrillation, can be obtained by either image/video image measure of images or by a sensor, PPG being an example of the sensor, the physiological measurements are connected to the first two purported species, measurement obtain by either image/video image measure of images or by a sensor, the physiological measurements **are connected in design and operation under the**

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disclosure and, therefore physiological measurements of image/video image and PPG are not separate species. **MPEP 806.04 (b).**

Claims 1, 24 and 44 are generic. Claims 2-9 are dependent on claim 1; Claims 25-34 are dependent on claim 24; and claims 1-9 and 25-34 can be practiced while performing any of the physiological measurements in the species. Since claims 1, 24 and 44 are independent claims, claims 1, 24 and 44 do not require material elements additional to those the species claims, and each of the species claims requires all the limitations of the independent (generic) claim. As such, claims 1, 24 and 44 are generic. (The definition of the generic claim is " a generic claim should require no material element additional to those required by the species claims, and each of the species claims must require all the limitations of the generic claim.") MPEP 806.04 (d)

The remaining dependent claims are dependent on one of the generic independent claims. Restriction of any of those dependent claims is really restriction within a single claim since a dependent claim incorporates the limitations of the independent claim. However, it is established law that the Director of the USPTO has no discretion to restrict within a single claim. In re Weber, 580 F. 2d 455, 458 (C.C.P.A. 1978); In re Haas, 580 F. 2d 461, 464 (C.C.P.A. 1978);

As the Court stated in Weber,

> As a general proposition, an applicant has a right to have each claim examined on the merits. If an applicant submits a number of claims, it may well be that pursuant to a proper restriction requirement, those claims will be dispersed to a number of applications. Such action would not affect the right of the applicant eventually to have each of the claims examined in the form he considers to best define his invention. If, however, a single claim is required to be divided up and presented in several applications, that claim would never be considered on its merits. The totality of the resulting fragmentary claims would not necessarily be the equivalent of the original claim. Further, since the subgenera would be defined by the examiner rather than by the applicant, it is not inconceivable that a number of the fragments would not be described in the specification.

In re Weber, 580 F. 2d at 458.

The Weber court, although recognizing that the Office needs to be able to manage examiner workloads at the searching done per patent application, held that the applicant's statutory right to claim his invention as he saw fit under section 112 trumped the administrative interest of the Office.

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As such, the restriction of the dependent claims according to species is contrary to law and should be removed.

Furthermore, the generic claims must be examined with, and thus are considered part of, the invention elected (MPEP 806.03). Since the generic claims must be examined with and are part of the invention provisionally elected and the generic claims combine all the identifying limitations of all of the species, the Examiner will have to search prior art for the limitations that identify each of the species. Therefore, having searched the generic claims, the Examiner would have searched prior art for all of the species. Since the "search and examination of an entire application can be made without serious burden," it must be examined on the merits. (MPEP 803).

Furthermore, it is well established that restriction is not mandatory merely because the subject matter of the claims may be separately classified. In light thereof, it is believed that an action on the merits of claims 1-53 in a single application is now in order.

III. CONCLUSION

In view of the foregoing discussion, Applicant respectfully requests that the requirement for restriction as to the Species, physiological measurements of image/video image; PPG; electrocardiogram; heart rate; respiratory; oxygen saturation; blood loss; and atrial fibrillation, should be withdrawn.

No fees are believed to be required for the consideration of this response. In the event that fees are required, the Director of Patents and Trademarks is hereby authorized to charge such fees, or to credit any overpayments, to Deposit Account No. 03-2410 (Order No. 30210-201).

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The following information is presented in the event that a call may be deemed desirable by the Examiner:

ORLANDO LOPEZ (617) 345-3000.

Respectfully submitted,

Dated: October 10, 2013 By: _____

Orlando Lopez
Reg. No. 46,880
Attorney for Patent Application Owners

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Electronic Acknowledgement Receipt

EFS ID:	17093604
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo Schepper Grolnic
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	10-OCT-2013
Filing Date:	20-JAN-2012
Time Stamp:	14:14:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		201RRRxx.pdf	815505 a19e91a81e5d1b0ec3519d42c9f33497fa2c 80f6	yes	19

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Response to Election / Restriction Filed	1	1
	Claims	2	15
	Applicant Arguments/Remarks Made in an Amendment	16	19
Warnings:			
Information:			
	Total Files Size (in bytes):	815505	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/354,941	01/20/2012	Ki H. Chon	30210-201	9133

26486 7590 11/01/2013

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EXAMINER	
LIU, CHU CHUAN	

ART UNIT	PAPER NUMBER
3777	

NOTIFICATION DATE	DELIVERY MODE
11/01/2013	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@burnslev.com

Office Action Summary	Application No. 13/354,941	Applicant(s) CHON ET AL.	
	Examiner CHU CHUAN (JJ) LIU	Art Unit 3777	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10/10/2013*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-53* is/are pending in the application.

5a) Of the above claim(s) *10-17,35-38 and 45-48* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-9,18-34,39-44 and 49-53* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *01/20/2012* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *09/10/2012*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

4) ☐ Other: _____.

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DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. The response to Election/ Restriction filed on 10/10/2013 is acknowledged.

3. Applicant provisional elected claims 1-9, 18-34, 39-44 and 49-53. In the response, applicant traversed the restriction requirement with arguments. However, applicant indicates that the physiological measurements, ECG, heart rate, respiratory rate, oxygen saturation, blood loss and atrial fibrillation can be obtained by either image/ video image or by a sensor (PPG). These physiological measurements are obtained by different type of sensors or detecting methods (optical, electrical, or others). Therefore, the species are independent or distinct because as disclosed the different species have mutually exclusive characteristics for each identified species. The restriction is hereby maintained by the reasons of record.

4. Claims 1-53 are pending for examination and claims 10-17, 35-38 and 45-48 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected inventions.

Claim Rejections - 35 USC § 101

5. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

6. Claim 44 and 49-53 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. The claims are directed to signal per se, which does not fall into the categories of "process", "machine", "manufacture" and "composition of matter". Referring to claim 44, claim 44 recites the limitation, "A computer readable medium", which directs the claim to "computer readable medium having computer readable code". The broadest reasonable interpretation of this phrase includes non-transitory embodiments, such as memory elements (ROM, RAM) and memory media (CDs) as well as transitory embodiments, such as carrier waves encoded with the software steps. However, transitory forms of signals are not statutory (*In re Nuijten*, 84 USPQ2d 1495). A claim that covers both statutory and non-statutory embodiments embraces subject matter that is improperly directed to non-statutory subject matter. Applicant can amend the limitation to "A non-transitory computer readable medium" to overcome the rejection.

Claim Rejections - 35 USC § 102/ 103

7. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

9. Claims 1-2, 8-9, 24-26, 33-34 and 44 are rejected under pre-AIA 35 U.S.C. 102(b) as anticipated by Kimball (USPN 6,879,850) or, in the alternative, under pre-AIA 35 U.S.C. 103(a) as obvious over Lichter et al. (USPN 6,159,147). In regard to claims 1, 24-25 and 44, Kimball discloses a method and an apparatus for physiological parameter monitoring (abstract; Col 1 line 54 – Col 2 line 53; Figs. 1-13), the method comprising: providing a physiological indicator signal (Figs. 1-8 and 10-13 and associated descriptions) to a mobile communication device (Figs. 1, 4 and 6); analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters (oxygen saturation, Col 1 line 54 – Col 2 line 53; Figs. 1-13); and detecting, using the mobile communications device, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements (Col 13 line 63 – Col 14 line 55). According to the definition disclosed in paragraph [0028] of the specification, a mobile communications device refers to a device capable of executing applications and is portable. The device taught by Kimball meets the limitation. If not inherent, Lichter teaches a mobile communications device (Fig. 3) which can be connected to various sensors to measure and analyze the collected data (Figs. 16). Kimball teaches different types of sensors can be connected to the device and provide data for analysis (Figs. 1-8 and 10-13 and associated descriptions). Therefore, it would have been obvious to one

with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Kimball) to incorporate the mobile communications device (Lichter) in order to obtain more physiological data from a plurality sensors applied to a patient.

In regard to claims 2 and 26, Kimball discloses the step of detecting effects of motion artifacts in the measurements comprises: a. preprocessing a segment from the measurement of one physiological parameter (obtaining pulse-ox signal, Figs. 2, 4, 6, 7, 10 and 13; Col 6 line 57 – Col 7 line 9; Col 9 lines 40-61; Col 12 line 41 – Col 13 line 14); b. obtaining a value of at least one indicator of volatility for the preprocessed segment (motion, Fig. 11); c. including the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present (Fig. 11 and Col 13 line 63 – Col 14 line 55); and d. selecting another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available (Fig. 11 and Col 13 line 63 – Col 14 line 55).

In regard to claims 8-9, 33-34, Kimball discloses providing a physiological indicator signal comprises obtaining a signal from a PPG sensor (abstract, Figs. 1-8 and 10-13 and associated descriptions).

Claim Rejections - 35 USC § 103

10. Claims 3-5 and 27-29 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kimball as applied to claims 1, 24 and 44 above, and further in view

of Addison et al. (USPGPUB 2005/0070774). In regard to claims 3-5 and 27-29, Kimball discloses all the claimed limitations except said at least one measure of volatility comprises kurtosis and Shannon entropy. Addison teaches a wavelet analysis for disassociation of artefacts from the signal detected by a pulse oximeter (abstract) comprises the use of kurtosis and entropy analyses ([0110]). It is known in the art that many types of entropies can be utilized in wavelet analysis as evidenced by [0048] of Sarkela (USPGPUB 2007/0197930). Wavelet analysis is another suitable method for removing/ reducing noise/ motion component containing the detected PPG signal (Addison). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Kimball) to incorporate wavelet analysis method (Addison) in order to better remove/ reduce noise/ motion artifacts contained in the detected physiological signals.

11. Claims 6, 30, and 53 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Kimball and Addison as applied to claims 1, 24 and 44 above, and further in view of Echauz et al. (USPN 6,678,548). In regard to claims 6, 30, and 53, Kimball as modified by Addison discloses all the claimed limitation except the predetermined threshold is determined using receiver operator characteristic (ROC) analysis. Echauz teaches a threshold value can be determined using receiver operator characteristic (ROC) analysis for changing the sensitivity of feature classifications which includes wavelet coefficients and entropy analysis (Col 4 lines 26-51; Col 21 line 56 – Col 22 line 7). Therefore, it would have been obvious to one with

ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Kimball as modified by Addison) to incorporate the ROC determined threshold (Echauz) in order to better removing/ reducing the noise content of the detected signals.

12. Claims 7 and 31-32 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kimball as applied to claim 1 above, and further in view of Jacobsen et al. (USPN 6,198,394). In regard to claims 7 and 31-32, Kimball discloses all the claim limitation except placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and obtaining video images of the portion of the subject's body. Jacobsen teaches placing a portion of a subject's body over an objective lens of a camera in a mobile communication device (element 376, Fig. 5A; Fig. 8; Col 13 lines 55-67); and obtaining video images of the portion of the subject's body (element 376, Fig. 5A; Fig. 8; Col 13 lines 55-67). The portable communication device taught by Jacobsen can be connected to various sensors applied to a user (Figs. 1-3, 5-7, and 8 and associated description) and provide video images associated with specific location of the user to the command center (Col 13 lines 55-67). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Kimball) to incorporate the camera of the portable communication device (Jacobsen) in order to obtain video images associated with specific location of the user and transferring to a central monitoring system/ unit.

13. Claims 18-22, 39-42, and 49-52 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kimball as applied to claim 1 above, and further in view of Zhang (USPGPUB 2009/0112110). In regard to claim 18, Kimball discloses the measurement of ECG signals but does not specifically discloses a measure of atrial fibrillation. Zhang teaches a measure of atrial fibrillation based on ECG signal analysis (abstract and Figs. 1-9). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method (Kimball) to incorporate the ECG-based atrial fibrillation analysis (Zhang) in order to obtain more health information of the user.

In regard to claims 19-22, 39-42, and 49-52, Kimball as modified by Zhang discloses comparing the ECG signals in two adjacent data segments (Figs. 5-9 and associated descriptions of Zhang), Shannon entropy analysis ([0042]), adaptive thresholds ([0036]), detecting threshold ([0041-0042]) but does not specifically disclose the recited limitations. However, time-varying coherence function(s) for analyzing two signals are known in the art as evidenced by Buck et al. (USPN 2010/0150375). Therefore, it would have obvious to one with ordinary skill in the art at the time of the invention was made to modify the method to incorporate time-varying coherence function analysis through investigations or researches in order to obtain optimal atrial fibrillation information.

14. Claims 23 and 43 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Kimball and Zhang as applied to claims 19-21 and

39-41 above, and further in view of Echauz. In regard to claims 6, 30, and 53, Kimball as modified by Zhang discloses all the claimed limitation except the predetermined threshold is determined using receiver operator characteristic (ROC) analysis. Echauz teaches a threshold value can be determined using receiver operator characteristic (ROC) analysis for changing the sensitivity of feature classifications which includes wavelet coefficients and entropy analysis (Col 4 lines 26-51; Col 21 line 56 – Col 22 line 7). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Kimball as modified by Zhang) to incorporate the ROC determined threshold (Echauz) in order to better removing/ reducing the noise content of the detected signals.

Double Patenting

1. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the claims at issue are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*,

686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the reference application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO internet Web site contains terminal disclaimer forms which may be used. Please visit http://www.uspto.gov/forms/. The filing date of the application will determine what form should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to http://www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

2. Claims 1, 18-23, 24-25, 39-43, 44, and 49-53 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-26 of copending Application No. 13/684,979. Although the claims at issue are not identical, they are not patentably distinct from each other. In regard to claims 1, 18-23, 24-25, 39-43, 44, and 49-53, claims 1-16 of '812 recite similar claim limitations except a noise analysis processing of the received physiological signals. However, noise reduction processes are well known in the art. Therefore, it would have been obvious to one with

ordinary skill in the art at the time of the invention was made to modify the method and the apparatus in incorporate a noise reduction processes in order to obtain optimal detection.

3. Claims 1, 24-25, and 44 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-5, 12-14, and 17-20 of copending Application No. 13/823,812. Although the claims at issue are not identical, they are not patentably distinct from each other because claims 1-5, 12-14, and 17-20 of '812 recite similar claim limitations.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to CHU CHUAN (JJ) LIU whose telephone number is (571)270-5507. The examiner can normally be reached on M-TH 7:00am~3:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tse Chen can be reached on (571)272-3672. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Chu Chuan Liu/
Examiner, Art Unit 3777

/Tse Chen/
Supervisory Patent Examiner, Art Unit 3777

Notice of References Cited	Application/Control No. 13/354,941	Applicant(s)/Patent Under Reexamination CHON ET AL.	
	Examiner CHU CHUAN (JJ) LIU	Art Unit 3777	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-6,879,850	04-2005	Kimball, Victor E.	600/336
*	B	US-6,159,147	12-2000	Lichter et al.	600/300
*	C	US-2005/0070774	03-2005	Addison et al.	600/323
*	D	US-6,678,548	01-2004	Echauz et al.	600/544
*	E	US-6,198,394	03-2001	Jacobsen et al.	340/573.1
*	F	US-2009/0112110	04-2009	Zhang, Hongxuan	600/518
*	G	US-2010/0150375	06-2010	Buck et al.	381/94.1
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13354941	CHON ET AL.
	Examiner	Art Unit
	CHU CHUAN (JJ) LIU	3777

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/24/2013								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	N								
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	27	✓								
	28	✓								
	29	✓								
	30	✓								
	31	✓								
	32	✓								
	33	✓								
	34	✓								
	35	N								
	36	N								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13354941	CHON ET AL.
	Examiner	**Art Unit**
	CHU CHUAN (JJ) LIU	3777

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	10/24/2013								
	37	N								
	38	N								
	39	✓								
	40	✓								
	41	✓								
	42	✓								
	43	✓								
	44	✓								
	45	N								
	46	N								
	47	N								
	48	N								
	49	✓								
	50	✓								
	51	✓								
	52	✓								
	53	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13354941	CHON ET AL.
	Examiner	Art Unit
	CHU CHUAN (JJ) LIU	3777

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
600	300, 301, 309, 310, 322, 323, 324, 326, 330, 336, 473, 476, 500, 501, 502, 508, 509,518	10/24/2013	CCL

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search (PALM and EAST)	10/23/2013	CCL
EAST Search (TEXT, USPGPUB, USPAT) See Search History	10/24/2013	CCL
Google NPL Search	10/24/2013	CCL

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/CHU CHUAN (JJ) LIU/ Examiner.Art Unit 3777	

Petitioner Ex-1004, 0150

Petitioner Ex-1004, 0150

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L2	248	time-varying with transfer with function	US-PGPUB; USPAT	OR	ON	2013/10/24 06:53
L3	4	L2 and coherence with input with output	US-PGPUB; USPAT	OR	ON	2013/10/24 06:53
S1	1	(13/354941).APP.	US-PGPUB; USPAT	OR	OFF	2013/09/05 09:39
S2	10	(Chon near2 Ki Lee near2 Jinseok Selvaraj near2 Nandakumar).in. and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/09/05 09:44
S3	4	("20060135860" | "20070078316" | "20100030088" | "7254425").PN.	US-PGPUB; USPAT	OR	ON	2013/09/05 09:48
S4	59	portable adj computer and 600/310-344.ccls.	US-PGPUB; USPAT	OR	ON	2013/09/05 09:58
S5	9	kimball.in. and 600/310-344.ccls.	US-PGPUB; USPAT	OR	ON	2013/09/05 09:59
S6	5	kurtosis and Shannon with entropy and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:15
S7	130	cubic adj spline and (pulse heart) adj rate and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:30
S8	700	red and blue and oxygen adj saturation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:32
S9	113	red and blue with image and oxygen adj saturation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:32
S10	108	red same blue with image and oxygen adj saturation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:36
S11	25	ratio$1 same red same blue with image and oxygen adj saturation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:38
S12	1	("4914512").PN.	US-PGPUB; USPAT	OR	OFF	2013/10/23 07:50
S13	1199	a adj b with saturation	US-PGPUB; USPAT	OR	ON	2013/10/23 07:51
S14	109	S13 and "600".clas.	US-PGPUB;	OR	ON	2013/10/23 07:51

			USPAT			
S15	2	blood adj loss and vfcdm and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:56
S16	2	blood with loss and vfcdm and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 07:56
S17	3	blood with loss and vfcdm	US-PGPUB; USPAT	OR	ON	2013/10/23 07:56
S20	2	atrial with fibrillation and tvtf	US-PGPUB; USPAT	OR	ON	2013/10/23 08:04
S21	2	tvtf and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 08:05
S22	118094	coherence with transfer with function and fibrillationand "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 08:07
S23	9	coherence with transfer with function and fibrillation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 08:07
S24	3	coherence with transfer with function and atrial with fibrillation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 08:08
S25	4031	atrial with fibrillation and "600".clas.	US-PGPUB; USPAT	OR	ON	2013/10/23 08:55
S26	1917	S25 and (ecg eeg ppg)	US-PGPUB; USPAT	OR	ON	2013/10/23 08:55
S27	80	S26 and ppg	US-PGPUB; USPAT	OR	ON	2013/10/23 08:56
S28	135	battery and (protable laptop notebook) and 600/310-344.ccls.	US-PGPUB; USPAT	OR	ON	2013/10/23 10:29
S29	81	ecg and oxygen with saturation and (mobile portable phone notebook laptop) and 600/310-344.ccls. and (camera image)	US-PGPUB; USPAT	OR	ON	2013/10/23 11:19
S30	125	ecg and oxygen with saturation and (mobile phone notebook laptop) and 600/300-344.ccls. and (camera)	US-PGPUB; USPAT	OR	ON	2013/10/23 11:21
S31	1	kurtosis and Shannon same entropy same (PPG plethymograph$1)	US-PGPUB; USPAT	OR	ON	2013/10/23 12:16
S32	3	kurtosis and Shannon same entropy and (PPG plethymograph$1)	US-PGPUB; USPAT	OR	ON	2013/10/23 12:17
S33	2	kurtosis and Shannon with entropy and (PPG plethymograph$1)	US-PGPUB; USPAT	OR	ON	2013/10/23 12:19
S34	24	kurtosis and Shannon with entropy	US-PGPUB; USPAT	OR	ON	2013/10/23 12:19
S35	2	kurtosis and Shannon with entropy and volatility	US-PGPUB;	OR	ON	2013/10/23 12:20

			USPAT			
S36	10	Shannon with entropy and volatility	US-PGPUB; USPAT	OR	ON	2013/10/23 12:20
S37	4	(("20050070774") or ("20020137995") or ("20080208012") or ("20090326353")).PN.	US-PGPUB; USPAT	OR	OFF	2013/10/23 12:27
S38	87	Receiver adj Operating adj Characteristic and wavelet and entrop$3	US-PGPUB; USPAT	OR	ON	2013/10/23 12:56
S39	78	S38 and threshold	US-PGPUB; USPAT	OR	ON	2013/10/23 12:57
S40	7	S38 and Receiver adj Operating adj Characteristic with threshold	US-PGPUB; USPAT	OR	ON	2013/10/23 13:04
S41	7	Receiver adj Operating adj Characteristic with threshold and wavelet and entropy	US-PGPUB; USPAT	OR	ON	2013/10/23 13:18
S42	251	fibrillation and ecg and entrop$3	US-PGPUB; USPAT	OR	ON	2013/10/23 13:41
S43	19	S42 and shannon with entrop$3	US-PGPUB; USPAT	OR	ON	2013/10/23 13:42
S44	248	time-varying with transfer with function	US-PGPUB; USPAT	OR	ON	2013/10/23 14:53
S45	54	S44 and (variance coherence)	US-PGPUB; USPAT	OR	ON	2013/10/23 14:54

EAST Search History (Interference)

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10/24/2013 7:55:19 AM
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PTO/SB/08a (01-10)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13354941
Filing Date	2012-01-20
First Named Inventor	Ki H. Chon et al.
Art Unit	1629
Examiner Name	TBD
Attorney Docket Number	30210-201 (US)

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7254425	B2	2007-08-07	Michael G. Lowery et al.	

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20060135860	A1	2006-06-22	Clark Baker et al.	
	2	20070078316	A1	2007-04-05	Hoarau Carine et al.	
	3	20100030088	A1	2010-02-04	Carney James Kevin et al.	

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							☐

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /CCL/

Petitioner Ex-1004, 0154

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13354941
	Filing Date	2012-01-20
	First Named Inventor	Ki H. Chon et al.
	Art Unit	1629
	Examiner Name	TBD
	Attorney Docket Number	30210-201 (US)

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report dated June 28, 2012 from co-pending PCT/US2012/022049, filed on January 20, 2012, which claims the benefit of U.S. Provisional Application Serial No. 61/434,856, filed on January 21, 2011.	☐
	2	Written Opinion from the International Searching Authority from co-pending PCT/US2012/022049, filed on January 20, 2012, which claims the benefit of U.S. Provisional Application Serial No. 61/434,856, filed on January 21, 2011.	☐

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EXAMINER SIGNATURE

Examiner Signature	/Chu Chuan Liu/	Date Considered	10/24/2013

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

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Petitioner Ex-1004, 0155

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/354,941	01/20/2012	Ki H. Chon	30210-201	9133

26486 7590 01/22/2014

BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

EXAMINER
LIU, CHU CHUAN

ART UNIT	PAPER NUMBER
3777	

NOTIFICATION DATE	DELIVERY MODE
01/22/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@burnslev.com

Applicant-Initiated Interview Summary	Application No.	Applicant(s)	
	13/354,941	CHON ET AL.	
	Examiner	Art Unit	
	CHU CHUAN (JJ) LIU	3777	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Chu Chuan Liu*. (3)_____.

(2) *Orlando Lopez*. (4)_____.

Date of Interview: *13 January 2013*.

Type: ☒ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☒101 ☐112 ☒102 ☒103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: *1*.

Identification of prior art discussed: *Kimball (USPN 6,879,850) and Lichter et al. (USPN 6,159,147)*.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

During the interview, potential claim amendments of "...detecting, using the mobile communications device and using only the measurements of one or more physiological parameters, effects of motion artifacts..." were discussed. Examiner generally aggred that the proposed claim amendments would overcome the 35 USC 102/ 103 rejection. Also, the proposed amendments of "non-transitory computer usable medium" would overcome the 35 USC 101 rejection. Examiner indicated that an updated search is required when the formal response has been filed.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/CHU CHUAN (JJ) LIU/ Examiner, Art Unit 3777	/TSE CHEN/ Supervisory Patent Examiner, Art Unit 3777

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiner's responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicant's correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
   (The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicant's record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiner's version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, "Interview Record OK" on the paper recording the substance of the interview along with the date and the examiner's initials.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon et al.
Serial Number: 13/354,941
Filed: 01-20-2012
Title: PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Examiner: LIU, CHU CHUAN
Group Art Unit: 3777
Confirmation No. 9133

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AMENDMENT AND RESPONSE TO OFFICE ACTION

Sir:

In reply to the non-final Office Action dated November 1, 2013, Applicants submit the following amendments and remarks.

Amendments to the claims begin on page 2 of this paper.

Remarks begin on page 16 of this paper.

Amendments to the Claims:

This listing of claims replaces all prior versions and listings of the claims.

1. (Currently amended) A method for physiological parameter monitoring, the method comprising:
providing a physiological indicator signal to a mobile communication device;

analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters; and

detecting, using the mobile communications device and using only the measurements of one or more physiological parameters, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements.

2. (Previously presented) The method of claim 1 wherein the step of detecting effects of motion artifacts in the measurements comprises:
   a. preprocessing a segment from the measurement of one physiological parameter;
   b. obtaining a value of at least one indicator of volatility for the preprocessed segment;
   c. including the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present; and
   d. selecting another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available.

3. (Previously presented) The method of claim 2 wherein said at least one indicator of volatility comprises kurtosis.

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4. (Previously presented) The method of claim 2 wherein said at least one indicator of volatility comprises Shannon entropy.

5. (Previously presented) The method of claim 2 wherein said at least one measure of volatility comprises kurtosis and Shannon entropy.

6. (Previously presented) The method of claim 2 wherein the predetermined threshold is determined using receiver operator characteristic (ROC) analysis.

7. (Previously presented) The method of claim 1 wherein providing a physiological indicator signal comprises:
placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and

obtaining video images of the portion of the subject's body.

8. (Previously presented) The method of claim 1 wherein providing a physiological indicator signal comprises obtaining a signal from a physiological monitoring sensor.

9. (Previously presented) The method of claim 8 wherein the physiological monitoring sensor is a photoplethysmographic (PPG) sensor or an electrocardiogram sensor.

10. (Withdrawn) The method of claim 1 wherein the one or more physiological measurements comprise heart rate and heart rate variability.

11. (Withdrawn) The method of claim 10 wherein obtaining measurements of heart rate and heart rate variability comprise:
determining beats for the physiological indicator signal;

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determining beat to beat intervals; and

applying a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

12. (Withdrawn) The method of claim 1 wherein the one or more physiological measurements comprise respiratory rate.

13. (Withdrawn) The method of claim 12 wherein measurement of respiratory rate comprises:
obtaining time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtaining respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

14. (Withdrawn) The method of claim 1 wherein the one or more physiological measurements comprise a measure of oxygen saturation.

15. (Withdrawn) The method of claim 14 wherein providing a physiological indicator signal comprises:
placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and

obtaining video images of the portion of the subject's body, and

wherein obtaining the measure of oxygen saturation comprises:
obtaining an average intensity of a red component and a blue component of the video images of the portion of the subject's body; the average intensity of the red component

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and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtaining a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtaining the measure of oxygen saturation (SpO2) by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}},$$

16. (Withdrawn) The method of claim 1 wherein the one or more physiological measurements comprise a measure of blood loss.

17. (Withdrawn) The method of claim 16 wherein obtaining the measure of blood loss comprises:
obtaining time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtaining the amplitude modulation (AM) series from a set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time–frequency spectrum; and

determining whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

18. (Previously presented) The method of claim 1 wherein the one or more physiological measurements comprise a measure of atrial fibrillation.

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19. (Previously presented) The method of claim 18 wherein obtaining the measure of atrial fibrillation comprises:

obtaining a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determining whether the time-varying coherence function is less than a predetermined quantity.

20. (Previously presented) The method of claim 19 wherein determining whether the time-varying coherence function is less than the predetermined quantity comprises:
obtaining one or more indicators of atrial fibrillation; and

determining whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

21. (Previously presented) The method of claim 20 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

22. (Previously presented) The method of claim 21 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

23. (Previously presented) The method of claim 20 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

24. (Currently amended) A system for physiological parameter monitoring, the system comprising:

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a physiological indicator signal sensing component; and a mobile communication device comprising:

an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters; and

a motion artifact detection component detecting, using only the measurements of one or more physiological parameters, effects of motion artifacts in the measurements of the one or more physiological parameters.

25. (Previously presented) The system of claim 24 wherein the mobile communications device comprises:
at least one processor; and

at least one computer usable medium, the computer usable medium having computer readable code embodied therein, the computer readable code causing the at least one processor to:

analyze the physiological indicator signal to obtain measurements of one or more physiological parameters; and

detect effects of motion artifacts in the measurements of the one or more physiological parameters.

26. (Previously presented) The system of claim 25 wherein the computer readable code, in causing the at least one processor to detect effects of motion artifacts, causes the at least one processor to:

a. preprocess a segment from the measurement of one physiological parameter;
b. obtain a value of at least one indicator of volatility for the preprocessed segment;
c. include the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold indicates noise/motion artifacts are not present;

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d. select another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available.

27. (Previously presented) The system of claim 26 wherein said at least one indicator of volatility comprises kurtosis.

28. (Previously presented) The system of claim 26 wherein said at least one indicator of volatility comprises Shannon entropy.

29. (Previously presented) The system of claim 26 wherein said at least one measure of volatility comprises kurtosis and Shannon entropy.

30. (Previously presented) The system of claim 26 wherein the predetermined threshold is determined using receiver operator characteristic (ROC) analysis.

31. (Original) The system of claim 24 wherein the physiological indicator signal sensing component comprises an image acquisition component, said acquisition component capable of acquiring a number of frames, each frame acquired at a predetermined time.

32. (Previously presented) The system of claim 31 wherein the mobile communications device comprises said image acquisition component.

33. (Previously presented) The system of claim 24 wherein the physiological indicator signal sensing component comprises a physiological monitoring sensor.

34. (Previously presented) The system of claim 33 wherein the physiological monitoring sensor is a photoplethysmographic (PPG) sensor or an electrocardiogram sensor.

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35. (Withdrawn) The system of claim 25 wherein the physiological indicator signal sensing component comprises an image acquisition component, said acquisition component capable of acquiring a number of frames, each frame acquired at a predetermined time; wherein said image acquisition component acquires a color image having red, green and blue components; wherein one or more physiological measurements comprise a measure of oxygen saturation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain an average intensity of a red component and a blue component of the images of a portion of a subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtain a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtain the measure of oxygen saturation by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}},$$

36. (Withdrawn) The system of claim 25 wherein the one or more physiological measurements comprise heart rate and heart rate variability; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

determine beats for the physiological indicator signal;
determine beat to beat intervals; and

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apply a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

37. (Withdrawn) The system of claim 25 wherein the one or more physiological measurements comprise respiratory rate; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtain respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

38. (Withdrawn) The system of claim 25 wherein the one or more physiological measurements comprise a measure of blood loss; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

obtain the amplitude modulation (AM) series from set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time–frequency spectrum; and

determine whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

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39. (Previously presented) The system of claim 25 wherein the one or more physiological measurements comprise a measure of atrial fibrillation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determine whether the time-varying coherence function is less than a predetermined quantity.

40. (Previously presented) The system of claim 39 wherein the computer readable code, in causing the at least one processor to determine whether the time-varying coherence function is less than the predetermined quantity, causes the at least one processor to:

obtain one or more indicators of atrial fibrillation; and
determine whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

41. (Previously presented) The system of claim 40 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

42. (Previously presented) The system of claim 41 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

43. (Previously presented) The system of claim 41 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

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44. (Currently amended) A non-transitory computer usable medium having computer readable code embodied therein, the computer readable code causing at least one processor to:

analyze a physiological indicator signal to obtain measurements of one or more physiological parameters; and

detect, using only the measurements of one or more physiological parameters, effects of motion artifacts in the measurements of the one or more physiological parameters.

45. (Withdrawn) The computer usable medium of claim 44 wherein the physiological indicator signal comprises a video color image having red, green and blue components, the video color image being an image obtained from of a portion of a subject's body; wherein the measurements of one or more physiological parameters comprise a measure of oxygen saturation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain an average intensity of the red component and a blue component of the video color image of a portion of a subject's body; the average intensity of the red component and the average intensity of the blue component constituting DC_{RED} and DC_{BLUE} respectively;

obtain a standard deviation of the red component and the blue component; the standard deviation of the red component and the blue component constituting AC_{RED} and AC_{BLUE} respectively; and

obtain the measure of oxygen saturation by

$$SpO2 = A - B\frac{AC_{RED}/DC_{RED}}{AC_{BLUE}/DC_{BLUE}}.$$

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46. (Withdrawn) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise heart rate and heart rate variability; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

determine beats for the physiological indicator signal;

determine beat to beat intervals; and

apply a cubic spline algorithm to obtain a substantially continuous beat to beat interval signal indicative of heart rate.

47. (Withdrawn) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise respiratory rate; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM); and

obtain respiratory rates by extracting a frequency component that has a largest amplitude for each time point at a heart rate frequency band.

48. (Withdrawn) The computer usable medium of claim 44 wherein the one or more physiological measurements comprise a measure of blood loss; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:
obtain time–frequency spectrum of the physiological indicator signal utilizing variable frequency complex demodulation (VFCDM);

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obtain the amplitude modulation (AM) series from set of the largest instantaneous amplitude at each time sample within the heart rate frequency band of the time–frequency spectrum; and

determine whether the amplitude modulation decreases; a decrease in the amplitude modulation indicating blood volume loss in subject.

49. (Currently amended) The non-transitory computer usable medium of claim 44 wherein the one or more physiological measurements comprise a measure of atrial fibrillation; and wherein the computer readable code, in causing the at least one processor to analyze the physiological indicator signal, causes the at least one processor to:

obtain a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals; and

determine whether the time-varying coherence function is less than a predetermined quantity.

50. (Currently amended) The non-transitory computer usable medium of claim 44 wherein the computer readable code, in causing the at least one processor to determine whether the time-varying coherence function is less than the predetermined quantity, causes the at least one processor to:

obtain one or more indicators of atrial fibrillation;
determine whether the one or more indicators of atrial fibrillation exceed predetermined thresholds.

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51. (Currently amended) The non-transitory computer usable medium of claim 50 wherein the one or more indicators of atrial fibrillation comprise a variance of the time-varying coherence function.

52. (Currently amended) The non-transitory computer usable medium of claim 51 wherein the one or more indicators of atrial fibrillation also comprise Shannon entropy.

53. (Previously presented) The computer usable medium of claim 50 wherein the predetermined thresholds are determined using receiver operator characteristic (ROC) analysis.

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REMARKS

Applicants have carefully reviewed the Office Action dated November 1, 2013, and this response addresses the Examiner's concerns. Applicants respectfully request reconsideration of the application.

I. STATUS OF THE CLAIMS

Claims 1-53 are pending.

Claims 10-17, 35-38 and 45-48 are withdrawn from consideration.

Claims 1-9, 18-34, 39-44 and 49-53 are rejected.

Claims 1, 24, 44 and 49-53 are amended.

Support in the specification for the claim amendments

Support in the specification for the amendments to claims 1, 24 and 44 can be found in paragraphs 33-37 of the specification. Applicants respectfully state that only the measurements of one or more physiological parameters are mentioned or disclosed anywhere in the specification for the detection of motion artifacts. These type of disclosure was used in the following BPAI (PTAB) opinions and cases: Ex parte Lin, No. 2009-0486 (B.P. A. I. May 7, 2009); *Ex parte* Starling, No. 95----2165, at 4----5 (B.P.A.I June 29, 1999); Univ. of S. Calif. v. Depuy Spine, Inc., Interference No. 105,653, at 21 (B.P.A.I. Nov. 23, 2010); *Ex parte* Burns, No. 2009----011778, at 2 (B.P.A.I. May 28, 2010).; *Ex parte* Kim, No. 2011----01867, at 9 (B.P.A.I. June 25, 2012); *Ex parte* Gragg, No. 2009----001469 (B.P.A.I. Oct. 5, 2009); *Ex parte* Toy, No. 2010----011832, at 2 (B.P.A.I. Apr. 18, 2012); *Ex parte* Deen, No. 2008----1005, at 7 (B.P.A.I. Nov. 26, 2008) and was also recently described by Chief Judge Rader in In Re Bimeda Research & Development Ltd. *In Re Bimeda Research & Development Ltd.*, 2012-1420 (Fed. Cir. July 25, 2013) (concurring opinion by Chief Judge Rader).

II. THE 35 U.S.C 101 REJECTIONS

Claim 44 and 49-53 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

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Claims 44 and 49-53 have been amended to recite a non-transitory computer usable medium.

Applicants respectfully state that the 35 USC 101 rejection has been traversed.

III. THE 35 U.S.C 102/103 REJECTIONS

Claims 1-2, 8-9, 24-26, 33-34 and 44 are rejected under pre-AIA 35 U.S.C. 102(b) as anticipated by Kimball (USPN 6,879,850) or, in the alternative, under pre-AIA 35 U.S.C. 103(a) as obvious over Lichter et al. (USPN 6,159,147).

Claims 1, 24 and 44 have been amended to recite that the detection of the effects of motion artifacts is performed using only the measurements of one or more physiological parameters. The physiological parameters are obtained from physiological indicator signals. A physiological parameter, to one skilled in the art, is a parameter related to physiology (see, for example, http://www.merriam-webster.com/dictionary/physiological) and physiology, to one skilled in the art, is branch of biology that deals with the functions and activities of life or of living matter (as organs, tissues, or cells) and of the phenomena involved (see, for example, http://www.merriam-webster.com/dictionary/physiology). Motion is not a physiological parameter.

Kimball teaches using a motion detector that provides a motion signal in addition to the physiological indicator signal (col. 13, line 63 to col. 14, line 28; col. 15, line 11 to line 56, Kimball). The signal from the motion detector, which is **not** a detector providing a measurement of one or more physiological parameters, is used to detect the possibility of motion artifacts. Applicants respectfully state that Kimball does not teach detection of the effects of motion artifacts being performed using only the measurements of one or more physiological parameters, a limitation of independent claims 1, 24 and 44. Applicants respectfully state that Lichter also does not teach detection of the effects of motion artifacts is performed using only the measurements of one or more physiological parameters.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987); MPEP 2131.

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Applicants respectfully state that Kimball does not anticipate amended claims 1, 24 and 44.

To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

Applicants respectfully state that neither Kimball nor Lichter, either separately or in combination, teach or suggest detection of the effects of motion artifacts being performed using only the measurements of one or more physiological parameters.

Applicants respectfully state that a *prima facie* case of obviousness has not been established for amended claims 1, 24 and 44.

Claims 2, 8-9 are dependent on claim 1. Claims 25-26 and 33-34 are dependent on claim 24.

Applicants respectfully state that claims 1-2, 8-9, 24-26, 33-34 and 44 are not anticipated by Kimball and that a *prima facie* case of obviousness has not been established for claims 1-2, 8-9, 24-26, 33-34 and 44.

Applicants do not acquiesce to the Examiner's argument regarding the dependent claims. Regarding claims 2 and 26, Applicants have defined in the specification, in page 5, lines 5-7, "volatility" to be a measure of the probability of obtaining an extreme value in the future. The examiner, in the office action has equated the indicator of volatility to motion. Applicants respectfully state that motion is not a measure of the probability of obtaining an extreme value in the future. Applicants respectfully state that Kimball does not teach at least two of the limitations of claims 2 and 26.

IV. THE 35 U.S.C 103 REJECTIONS

Claims 3-5 and 27-29 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kimball as applied to claims 1, 24 and 44 above, and further in view of Addison et al. (USPGPUB 2005/0070774).

Claims 3-5 are dependent on claim 1 and claims 27-29 are dependent on claim 24. As stated above, Kimball does not teach or suggest at least one limitation of amended claims 1, 24 or 44, detection of the effects of motion artifacts being performed using only the

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measurements of one or more physiological parameters. Applicants respectfully state that Addison also does not teach or suggest the missing limitations.

Applicants respectfully state that a prima facie case of obviousness has not been established for claims 3-5 and 27-29.

However, applicants do not acquiesce to the examiner's arguments regarding Addison. Addison et al. suggest the calculation of kurtosis and entropy for the wavelet transformed signal. The kurtosis is defined as:

$$k = \frac{E(x-\mu)^4}{\sigma^4} \quad (1)$$

where μ is the mean of x, σ is the standard deviation of x, and $E(t)$ represents the expected value of the quantity t (specification, page 9, lines 25-30)

and the Shannon entropy SE can be calculated as

$$SE = -\sum_{i=1}^{k} \frac{p(i)*\log(p(i))}{\log(\frac{1}{2})} \quad (2)$$

where i represents the bin number, and $p(i)$ is the probability distribution of the signal amplitude (specification, page10, lines 4-8).

Applicants respectfully state that none of the properties of the continuous wavelet transform, linearity, shift property, scaling property energy conservation or localization properties (see, for example Vetterli, Kovacevic, Wavelets and Subband Coding, ISBN 0-13-097080-8, 1995, pp. 304-308) indicate that the inverse transform of the kurtosis of the wavelet transforms signal is the same as the kurtosis of the preprocessed segment of the measurement of one physiological parameter, which is recited in claim 3. By a similar argument, Sarkela (cited by the examiner) calculate the entropy in terms of the coefficients of the wavelet transform. Applicants respectfully state that none of the properties of the continuous wavelet transform indicate that the inverse transform of the entropy calculated by Sarkela is the same as the Shannon entropy calculated from the preprocessed segment of the measurement of one physiological parameter.

Applicants respectfully state that neither Kimball nor Addison, either separately or in combination, teach or suggest all the limitations of claims 3-5 and 27-29.

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Claims 6, 30, and 53 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Kimball and Addison as applied to claims 1, 24 and 44 above, and further in view of Echauz et al. (USPN 6,678,548).

Claim 6 is dependent on claim 1; claims 30 is dependent on claim 24 and claim 53 is dependent on claim 44.

As stated above, Kimball does not teach or suggest at least one limitation of amended claims 1, 24 or 44, detection of the effects of motion artifacts being performed using only the measurements of one or more physiological parameters. Applicants respectfully state that neither Addison nor Echauz teach or suggest the missing limitations.

Applicants respectfully state that a *prima facie* case of obviousness has not been established for Claims 6, 30, and 53.

Claims 7 and 31-32 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kimball as applied to claim 1 above, and further in view of Jacobsen et al. (USPN 6,198,394).

Claim 7 is dependent on claim 1 and claims 31-32 are dependent on claim 24.

As stated above, Kimball does not teach or suggest at least one limitation of amended claims 1, 24 or 44, detection of the effects of motion artifacts being performed using only the measurements of one or more physiological parameters. Applicants respectfully state that Jacobsen also does not teach or suggest the missing limitations.

Applicants respectfully state that a *prima facie* case of obviousness has not been established for claims 7 and 31-32.

Claims 18-22, 39-42, and 49-52 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Kimball as applied to claim 1 above, and further in view of Zhang (USPGPUB 2009/0112110).

Claims 18-22 are dependent on claim 1; claims 39-42 are dependent on claim 24 and claims 49-52 are dependent on claim 44.

As stated above, Kimball does not teach or suggest at least one limitation of amended claims 1, 24 or 44, detection of the effects of motion artifacts being performed using only the

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measurements of one or more physiological parameters. Applicants respectfully state that Zhang also does not teach or suggest the missing limitations.

Applicants do not acquiesce to the Examiner's assertions regarding Zhang. Applicants respectfully state that neither Zhang nor Buck et al. (USPN 2010/0150375) teach or suggest "obtaining a time-varying coherence function by multiplying two time-varying transfer functions (TVFTs), the two time-varying transfer functions obtained using two adjacent data segments with one data segment as input signal and the other data segment as output to produce the first TVTF; the second TVTF is produced by reversing the input and output signals," a limitation of claim 19.

Applicants respectfully state that a *prima facie* case of obviousness has not been established for claims 7 and 31-32.

Claims 23 and 43 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Kimball and Zhang as applied to claims 19-21 and 39-41 above, and further in view of Echauz.

Claim 23 is dependent on claim 1 and claim 43 is dependent on claim 24. As stated above, Kimball does not teach or suggest at least one limitation of amended claims 1, 24 or 44, detection of the effects of motion artifacts being performed using only the measurements of one or more physiological parameters. Applicants respectfully state that neither Zhang nor Echauz teach or suggest the missing limitations.

Applicants respectfully state that a *prima facie* case of obviousness has not been established for claims 23 and 43.

V. DOUBLE PATENTING

Claims 1, 18-23, 24-25, 39-43, 44, and 49-53 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-26 of co-pending Application No. 13/684,979.

Applicants respectfully state that co-pending Application No. 13/684,979 was filed on November 26, 2012 and the present application was filed on January 20, 2012. The claims of co-

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pending Application No. 13/684,979 are not prior art to the present application and a nonstatutory double patenting rejection is not proper.

Claims 1, 24-25, and 44 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-5, 12-14, and 17-20 of co-pending Application No. 13/823,812.

As shown in the table below, claims 1-5, 12-14, and 17-20 of co-pending Application No. 13/823,812 do not teach or suggest all the limitations of claims 1, 24-25 and 44.

Claims of 13/823,812	Present application claims	Remarks
1. A method for detecting motion and noise artifacts in an electrocardiogram (ECG) recording, comprising: receiving an ECG segment; decomposing the received ECG segment into a sum of intrinsic mode functions; isolating intrinsic mode functions associated with motion and noise artifacts present within the ECG segment; determining randomness and variability characteristic values associated with the isolated intrinsic mode functions; comparing the randomness and variability characteristic values to threshold randomness and variability characteristic values; and determining that the received ECG segment includes motion and noise artifacts if the randomness and variability characteristic values exceed the threshold randomness and variability characteristic values. 2. The method of claim 1, wherein the ECG segment is recorded by an ambulatory ECG recording device. 3. The method of claim 1, wherein decomposing the received ECG segment into a sum of intrinsic mode functions comprises performing empirical mode decomposition (EMD) on the received ECG segment.	53. (Currently amended) A method for physiological parameter monitoring, the method comprising: providing a physiological indicator signal to a mobile communication device; analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters; and detecting, using the mobile communications device, and using only the measurements of one or more physiological parameters, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements.	The method of claims 1-5 of 13/823812 only teaches the detection of motion and noise artifacts in ECGs and does not teach providing a physiological indicator signal to a mobile communication device or deciding whether to retain the measurements.

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4. The method of claim 1, wherein isolating intrinsic mode functions associated with motion and noise artifacts present within the ECG segment further comprises: identifying first order intrinsic mode functions; squaring the identified first order intrinsic mode functions; and normalizing the squared first order intrinsic mode functions. 5. The method of claim 4, further comprising discarding squared first order intrinsic mode functions that have peaks that exceed a predefined threshold value.		
12. A system for detecting motion and noise artifacts in an electrocardiogram (ECG) recording, comprising: a processor; a memory; and a real-time motion and noise artifact detection application, comprising: an ECG reception module that receives an ECG segment, an empirical mode decomposition module that decomposes the received ECG segment into a sum of intrinsic mode functions, a signal processing module that isolates intrinsic mode functions associated with motion and noise artifacts present within the ECG segment, at least one characteristic calculation module that determines randomness and variability characteristic values associated with the isolated intrinsic mode functions, and a ECG determination module that compares randomness and variability characteristic values to threshold randomness and variability characteristic values and determines that the received ECG segment includes motion and noise artifacts if the randomness and variability characteristic values exceed the threshold randomness and variability characteristic values.	24. A system for physiological parameter monitoring, the system comprising: a physiological indicator signal sensing component; and a mobile communication device comprising: an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters; and a motion artifact detection component detecting effects of motion artifacts in the measurements of the one or more physiological parameters. 25. The system of claim 24 wherein the mobile communications device comprises: at least one processor; and	The system of claim 12-14 of 13/823812 only provides a system for detection of noise and motion artifacts in an ECG recording and does not include a mobile communication device comprising: an analysis component analyzing the physiological indicator signal to obtain measurements of one or more physiological parameters.

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13. The system of claim 12, wherein the ECG reception module receives ECG signals from an electrocardiogram recording device. 14. The system of claim 12, wherein the signal processing module that isolates intrinsic mode functions associated with motion and noise artifacts present within the ECG segment comprises: an identification module that identifies first order intrinsic mode functions a squaring module that squares the identified first order intrinsic mode functions; and a scaling module that normalizes the squared first order intrinsic mode functions.	at least one computer usable medium, the computer usable medium having computer readable code embodied therein, the computer readable code causing the at least one processor to: analyze the physiological indicator signal to obtain measurements of one or more physiological parameters; and detect effects of motion artifacts in the measurements of the one or more physiological parameters.	
17. A computer-readable storage medium, having computer-executable instructions stored thereon, which when executed by a processor, cause the computer to: receive an ECG segment; decompose the received ECG segment into a sum of intrinsic mode functions; isolate intrinsic mode functions associated with motion and noise artifacts present within the ECG segment; determine randomness and variability characteristic values associated with the isolated intrinsic mode functions; compare the randomness and variability characteristic values to threshold randomness and variability characteristic values; and determine that the received ECG segment includes motion and noise artifacts if the randomness and variability characteristic values exceed the threshold randomness and variability characteristic values. 18. The computer-readable storage medium of claim 17, wherein decomposing the received ECG segment into a sum of	44. A computer usable medium having computer readable code embodied therein, the computer readable code causing at least one processor to: analyze a physiological indicator signal to obtain measurements of one or more physiological parameters; and detect effects of motion artifacts in the measurements of the one or more physiological parameters.	The computer readable storage medium of claims 17-20 of 13/823812 only provides instructions for detection of noise and motion artifacts in an ECG recording and does not include instructions to analyze a physiological indicator signal to obtain measurements of one or more physiological parameters.

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intrinsic mode functions comprises performing empirical mode decomposition (EMD) on the received ECG segment. 19. The computer-readable storage medium of claim 17, wherein isolating intrinsic mode functions associated with motion and noise artifacts present within the ECG segment further comprises: identifying first order intrinsic mode functions; squaring the identified first order intrinsic mode functions; and normalizing the squared first order intrinsic mode functions. 20. The computer-readable storage medium of claim 19, further comprising discarding squared first order intrinsic mode functions that have peaks that exceed a predefined threshold value.		

Applicants respectfully state that, since a *prima facie* case of obviousness has not been established, nonstatutory double patenting is not proper and the rejection has been traversed.

VI. CONCLUSION

Any amendments to the claims as set forth herein, including the modification, addition, cancellation, or withdrawal of any claims, have been offered to advance this application to issue. None of the amendments made herein should be construed as an admission that the subject matter of the claims, as originally filed, is anticipated by or made obvious in light of any art of record whether considered singularly or in combinations. Applicants expressly reserve the right to pursue the originally filed claims in another co-pending application without being prejudiced by any amendments, including cancellation of claims, made herein.

If the Examiner has any further questions regarding this amendment, he/she is invited to call Applicant's attorney at the number listed below.

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The Director of Patents and Trademarks is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account 03-2410 (Order No. 30210-201).

The following information is presented in the event that a call may be deemed desirable by the Examiner:

ORLANDO LOPEZ (617) 345-3000.

Respectfully submitted,

Dated: January 24, 2014

By: _____

Orlando Lopez
Reg. No. 46,880
Attorney for Patent Application Owners

Petitioner Ex-1004, 0184

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon et al.
Serial Number: 13/354,941
Filed: 01-20-2012
Title: PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE

Examiner: LIU, CHU CHUAN
Group Art Unit: 3777
Confirmation No. 9133

Burns & Levinson LLP
125 Summer Street
Boston, MA 02110
(617) 345-3000

To: Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT OF SUBSTANCE OF THE INTERVIEW

Sir:

Pursuant to 37 CFR 1.133, Applicants' attorney submits the following written statement of the substance of the telephone interview conducted on January 13, 2014 between Orlando Lopez, Applicants' representative, and Examiner Chu Chuan Li.

Claims discussed
Claim 1

Prior Art discussed
Kimball (USPN 6,879,850) and Lichter et al. (USPN 6,159,147)

Outcome
No agreement was reached.

In accordance with Section 714.01 of the MPEP, the following information is presented in the event that a call may be deemed desirable by the Examiner:
ORLANDO LOPEZ (617) 345-3000.

Respectfully submitted,

Dated: January 24, 2014

By: _____
Orlando Lopez
Reg. No. 46,880
Attorney for Patent Application Owner

Electronic Acknowledgement Receipt

EFS ID:	18017474
Application Number:	13354941
International Application Number:	
Confirmation Number:	9133
Title of Invention:	PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Marlo Schepper Grolnic
Filer Authorized By:	
Attorney Docket Number:	30210-201
Receipt Date:	24-JAN-2014
Filing Date:	20-JAN-2012
Time Stamp:	14:38:06
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		201ROASS.pdf	1342901 17de9e406eabbb227ce9c971df477f266e4f291	yes	27

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	15
	Applicant Arguments/Remarks Made in an Amendment	16	26
	Applicant summary of interview with examiner	27	27
Warnings:			
Information:			
	Total Files Size (in bytes):	1342901	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
13/354,941	01/20/2012	

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **01/24/2014**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 53	Minus	** 53	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $210 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/JACQUELINE COUPLIN/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/354,941	01/20/2012	Ki H. Chon	30210-201	9133

26486 7590 03/21/2014

BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

EXAMINER
LIU, CHU CHUAN

ART UNIT	PAPER NUMBER
3777	

NOTIFICATION DATE	DELIVERY MODE
03/21/2014	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@burnslev.com

Office Action Summary	Application No. 13/354,941	Applicant(s) CHON ET AL.	
	Examiner CHU CHUAN (JJ) LIU	Art Unit 3777	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01/24/2014*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-53* is/are pending in the application.

5a) Of the above claim(s) *10-17,35-38 and 45-48* is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-9, 18-34, 39-44 and 49-53* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

4) ☐ Other: _____.

Petitioner Ex-1004, 0190

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. Applicant's amendments/ Remarks filed on 01/24/2014 have been fully considered.

3. Claims 1-53 are pending. Claims 10-17, 35-38 and 45-48 are withdrawn from consideration.

Claim Rejections - 35 USC § 102/ 103

4. The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1-2, 8-9, 24-26, 33-34 and 44 are rejected under pre-AIA 35 U.S.C. 102(b) as anticipated by Diab et al. (USPN 6,067,462) or, in the alternative, under pre-AIA 35 U.S.C. 103(a) as obvious over Lichter et al. (USPN 6,159,147 – cited in previous

action). In regard to claims 1, 24-25 and 44, Diab discloses a method and an apparatus for physiological parameter monitoring (abstract; Figs. 3-19), the method comprising: providing a physiological indicator signal (abstract; Col 1 lines 10-21; Col 3 line 12 – Col 4 line 33) to a mobile communication device (Figs. 3 and 19); analyzing, using the mobile communications device, the physiological indicator signal to obtain measurements of one or more physiological parameters (pulse rate, abstract; oxygen saturation, Col 6 line 24 – Col 7 line 65); and detecting, using the mobile communications device and using only the measurements of the one or more physiological parameters, effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements (Figs. 11-13 and associated descriptions). According to the definition disclosed in paragraph [0028] of the specification, a mobile communications device refers to a device capable of executing applications and is portable. The device taught by Diab meets the limitation. If not inherent, Lichter teaches a mobile communications device (Fig. 3) which can be connected to various sensors to measure and analyze the collected data (Figs. 16). Diab teaches an oximeter sensor which provides measurement data to an oximeter for analysis and calculation (Figs. 3 and 19 and associated descriptions). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Diab) to incorporate the mobile communications device (Lichter) in order to obtain more physiological data from a plurality sensors applied to a patient.

In regard to claims 2 and 26, Diab discloses the step of detecting effects of motion artifacts in the measurements comprises: a. preprocessing a segment from the measurement of one physiological parameter (element 330, Fig. 1 and associated descriptions); b. obtaining a value of at least one indicator of volatility for the preprocessed segment (α, Fig. 13 and associated descriptions); c. including the segment in analyses of physiological measurements, if comparison of the value of the at least one indicator of volatility with a predetermined threshold (block 1308, Fig. 13 and associated descriptions) indicates noise/motion artifacts are not present (block 1310, Fig. 13 and associated description); and d. selecting another segment of the signal from the physiological measurement and proceeding to step (a), if the value of the at least one indicator of volatility is less than a predetermined threshold and another segment is available (block 1310, Fig. 13 and associated description; continuous analysis of optical measurements, Col 23 lines 11-17).

In regard to claims 8-9, 33-34, Diab discloses providing a physiological indicator signal comprises obtaining a signal from a PPG sensor (Fig. 2A, 3 and 19 and associated descriptions; claims 4-5).

Claim Rejections - 35 USC § 103

7. Claims 3-5 and 27-29 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Diab as applied to claims 1, 24 and 44 above, and further in view of Addison et al. (USPGPUB 2005/0070774 – cited in previous action). In regard to claims 3-5 and 27-29, Diab discloses all the claimed limitations except said at least one

measure of volatility comprises kurtosis and Shannon entropy. Addison teaches a wavelet analysis for disassociation of artifacts from the signal detected by a pulse oximeter (abstract) comprises the use of kurtosis and entropy analyses ([0110]). It is known in the art that many types of entropies, such as Shannon entropy can be utilized in wavelet analysis as evidenced by [0048] of Sarkela (USPGPUB 2007/0197930 – cited in previous action). Wavelet analysis is another suitable method for removing/ reducing noise/ motion component containing the detected PPG signal (Addison). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Diab) to incorporate wavelet analysis method (Addison) in order to better remove/ reduce noise/ motion artifacts contained in the detected physiological signals.

8. Claims 6, 30, and 53 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Diab and Addison as applied to claims 1, 24 and 44 above, and further in view of Echauz et al. (USPN 6,678,548 – cited in previous action). In regard to claims 6, 30, and 53, Daib as modified by Addison discloses all the claimed limitation except the predetermined threshold is determined using receiver operator characteristic (ROC) analysis. Echauz teaches a threshold value can be determined using receiver operator characteristic (ROC) analysis for changing the sensitivity of feature classifications which includes wavelet coefficients and entropy analysis (Col 4 lines 26-51; Col 21 line 56 – Col 22 line 7). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made

to modify the method and the apparatus (Diab as modified by Addison) to incorporate the ROC determined threshold (Echauz) in order to better removing/ reducing the noise content of the detected signals.

9. Claims 7 and 31-32 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Diab as applied to claims 1, 24-25 and 44 above, and further in view of Jacobsen et al. (USPN 6,198,394 – cited in previous action). In regard to claims 7 and 31-32, Diab discloses all the claim limitation except placing a portion of a subject's body over an objective lens of a camera in a mobile communication device; and obtaining video images of the portion of the subject's body. Jacobsen teaches placing a portion of a subject's body over an objective lens of a camera in a mobile communication device (element 376, Fig. 5A; Fig. 8; Col 13 lines 55-67); and obtaining video images of the portion of the subject's body (element 376, Fig. 5A; Fig. 8; Col 13 lines 55-67). The portable communication device taught by Jacobsen can be connected to various sensors applied to a user (Figs. 1-3, 5-7, and 8 and associated description) and provide video images associated with specific location of the user to the command center (Col 13 lines 55-67). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Diab) to incorporate the camera of the portable communication device (Jacobsen) in order to obtain video images associated with specific location of the user and transferring to a central monitoring system/ unit.

10. Claims 18-22, 39-42, and 49-52 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Diab as applied to claims 1, 24-25 and 44 above, and further in view of Zhang (USPGPUB 2009/0112110 – cited in previous action). In regard to claim 18, Diab discloses the measurement of ECG signals (Col 23 lines 51-57) but does not specifically discloses a measure of atrial fibrillation. Zhang teaches a measure of atrial fibrillation based on ECG signal analysis (abstract and Figs. 1-9). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method (Diab) to incorporate the ECG-based atrial fibrillation analysis (Zhang) in order to obtain more health information of the user.

In regard to claims 19-22, 39-42, and 49-52, Diab as modified by Zhang discloses comparing the ECG signals in two adjacent data segments (Figs. 5-9 and associated descriptions of Zhang), Shannon entropy analysis ([0042] of Zhang), adaptive thresholds ([0036] of Zhang), detecting threshold ([0041-0042] of Zhang) but does not specifically disclose the recited limitations. However, time-varying coherence function(s) for analyzing two signals are known in the art as evidenced by Buck et al. (USPN 2010/0150375 – cited in previous action). Therefore, it would have obvious to one with ordinary skill in the art at the time of the invention was made to modify the method to incorporate time-varying coherence function analysis through investigations or researches in order to obtain optimal atrial fibrillation information.

11. Claims 23 and 43 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over the combination of Diab and Zhang as applied to claims 19-21 and

39-41 above, and further in view of Echauz. In regard to claims 6, 30, and 53, Diab as modified by Zhang discloses all the claimed limitation except the predetermined threshold is determined using receiver operator characteristic (ROC) analysis. Echauz teaches a threshold value can be determined using receiver operator characteristic (ROC) analysis for changing the sensitivity of feature classifications which includes wavelet coefficients and entropy analysis (Col 4 lines 26-51; Col 21 line 56 – Col 22 line 7). Therefore, it would have been obvious to one with ordinary skill in the art at the time of the invention was made to modify the method and the apparatus (Diab as modified by Zhang) to incorporate the ROC determined threshold (Echauz) in order to better removing/ reducing the noise content of the detected signals.

Response to Arguments

12. Applicant's amendment and argument with respect to claims 1-9, 18-34, 39-44 and 49-53 filed on 01/24/2014 have been fully considered but they are deemed to be moot in views of the new grounds of rejection.

13. Applicant's arguments, see page 16-17 of Remarks, filed on 01/24/2014, with respect to claims 44 and 49-53 have been fully considered and are persuasive. The 35 USC 101 rejection of claims 44 and 49-53 has been withdrawn.

14. Applicant's arguments, see page 21-25 of Remarks, filed on 01/24/2014, with respect to claims 1, 18-23, 24-25, 39-43, 44, and 49-53 and claims 1, 24-25, and 44 have been fully considered and are persuasive. The provisional double patenting

rejection to 13/684,979 of claims 1, 18-23, 24-25, 39-43, 44, and 49-53; 13/823,812 of claims 1, 24-25, and 44 have been withdrawn.

15. In regard to claims 3-5 and 27-29, applicant alleged that none of the properties of the continuous wavelet transform, linearity, shift property, scaling property energy conservation or localization indicate that the inverse transform of the kurtosis of the wavelet transforms signal is the same as the kurtosis of the preprocessed segment of the measurement of one physiological parameter. It is noted that claim 2 recites an open-ended term of "comprises". The limitation of "at least one indicator of volatility" does not exclude other indicators suitable for other analyses.

Conclusion

16. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of