Figure 5

Bottom plot shows example automatic marking of QRS complexes (squares, as in 504) & detected ventricular tachycardia (circles, as in 503). Note the computed dynamic confidence signal 505 (dashed line on top plot) is updated for each cardiac cycle and varies with QRS amplitude & noise.

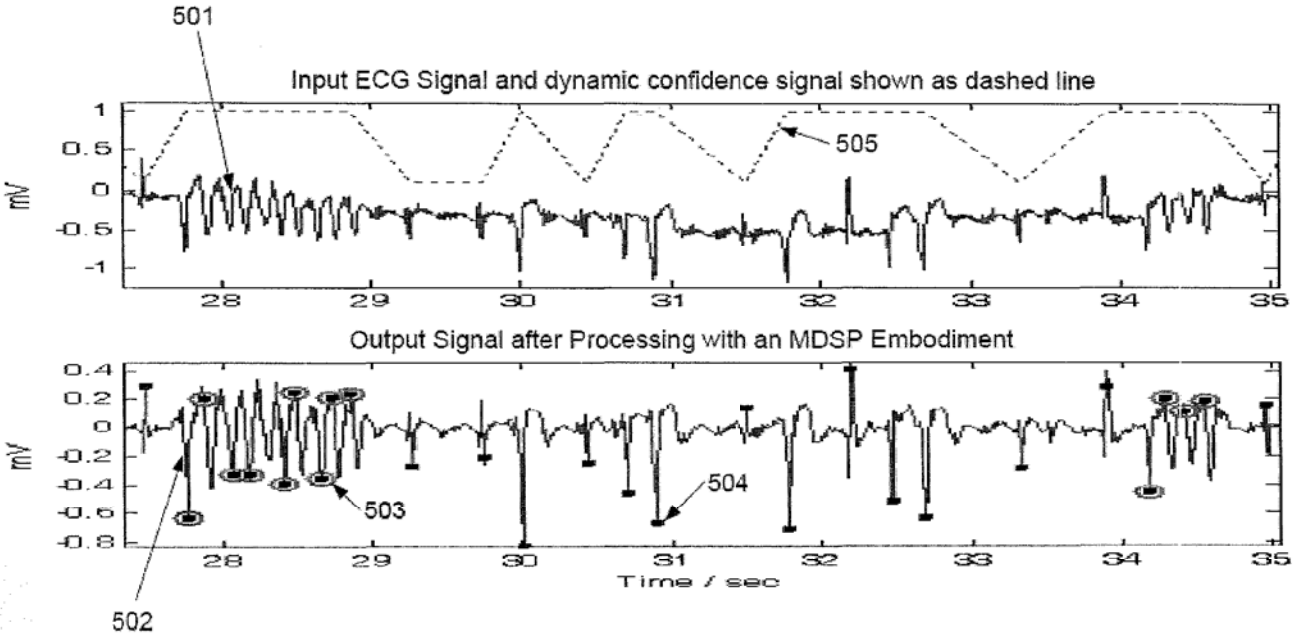


Figure 6 – MDSP
Example of denoising performance on three lead ECG processed with PCA, ICA, and MDF

- Quality of signal reconstruction for each of these techniques is as shown below for each lead of the 3-lead recording:
- MDF embodiment of MDSP [98% 99% 92%]
- PCA [83% 68% 71%]
  ICA [2% 1% 4%].

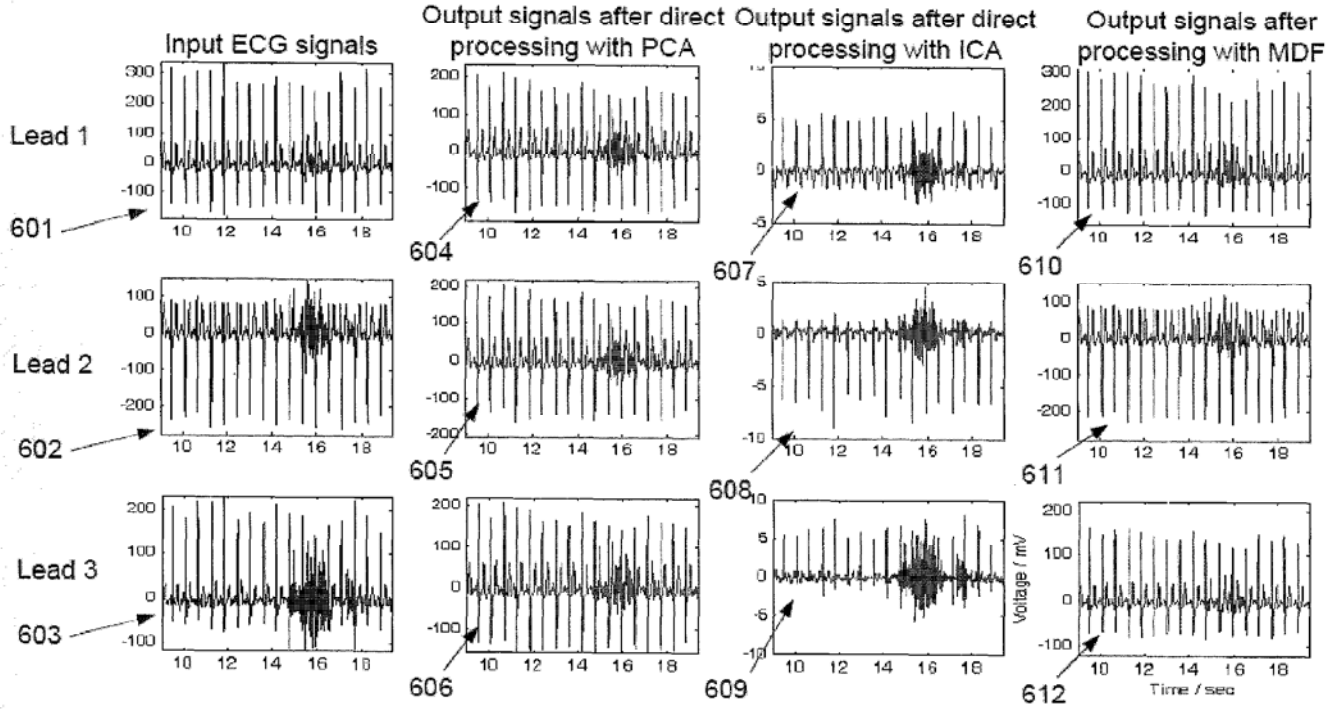


Figure 7

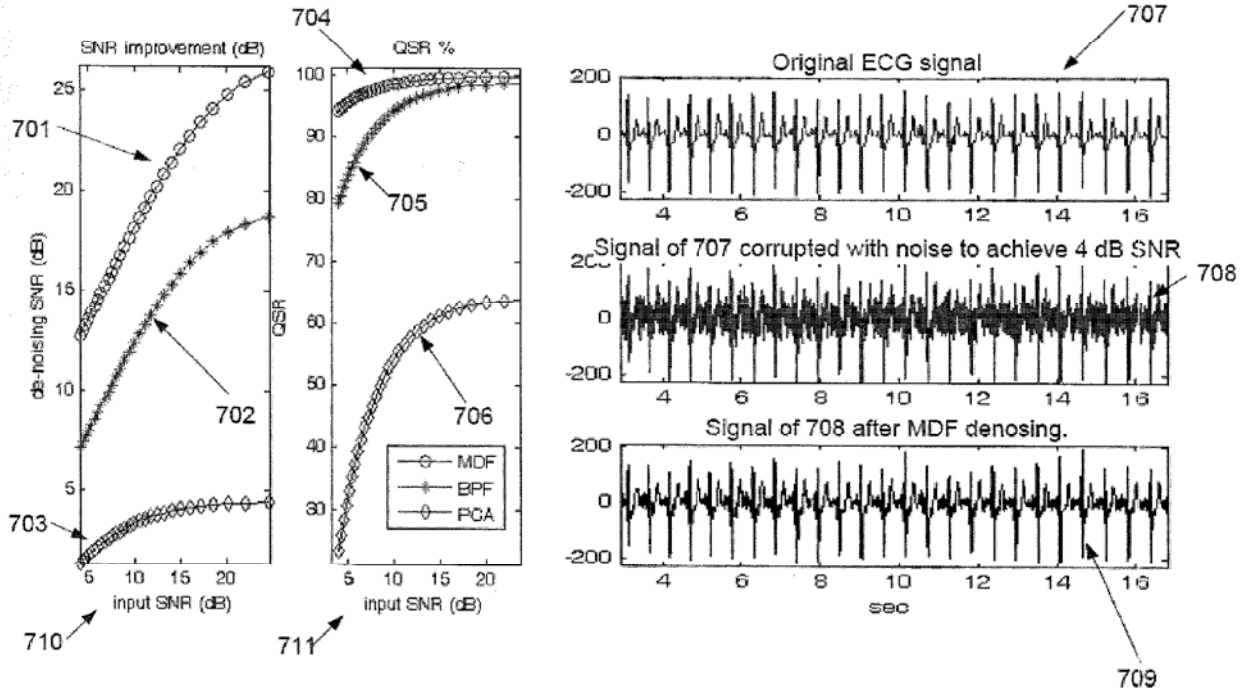

SNR improvement (dB)
QSR %
dB-noising SNR (dB)
QSR
input SNR (dB)
input SNR (dB)
MDF
BPF
PCA
701
702
703
704
705
706
710
711
Original ECG signal
Signal of 707 corrupted with noise to achieve 4 dB SNR
Signal of 708 after MDF denosing.
sec
707
708
709

Figure 8
Example result of ECG input signal processed with MDSP demonstrating denoising and morphology preservation for very noisy signal

Note that the morphology of the P and QRS waves are preserved after denoising (802).

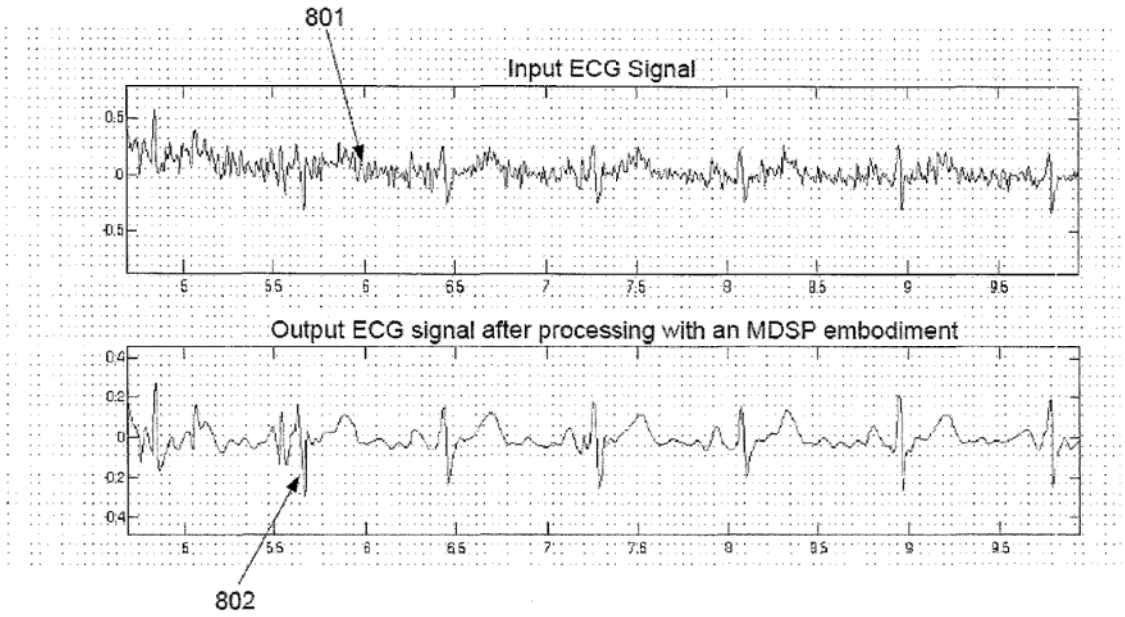


Figure 9
Example of atrial activity extraction in an ECG with atrial flutter using an MDSP embodiment

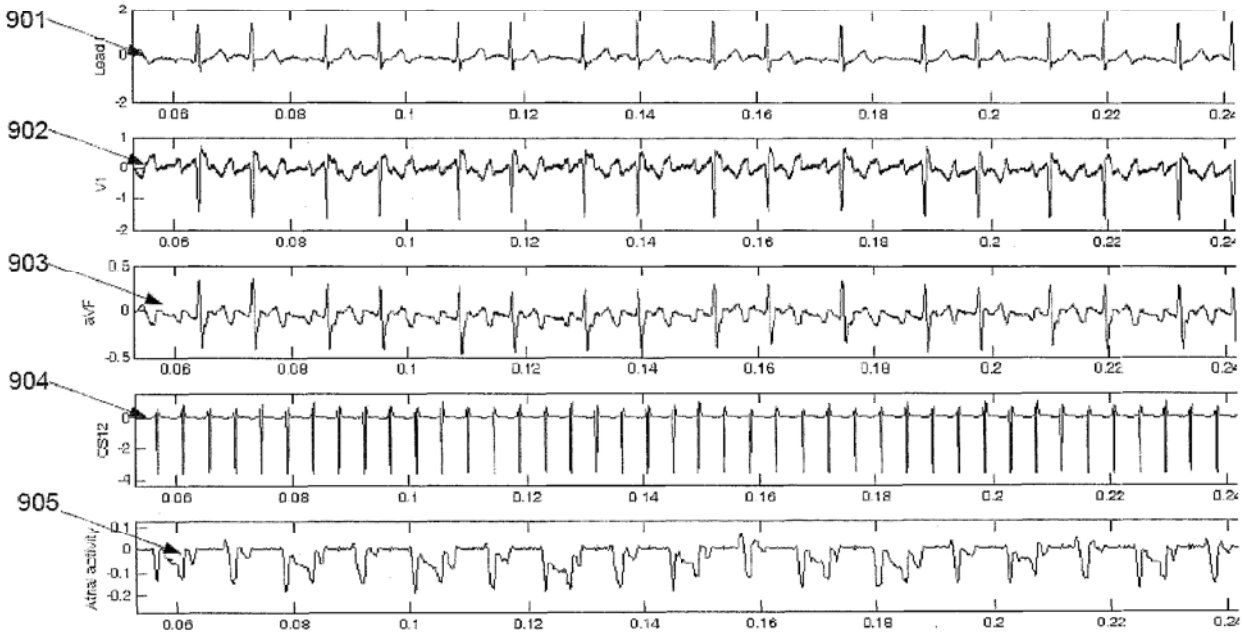


Figure 10
Example of atrial activity extracted from an ECG with atrial fibrillation

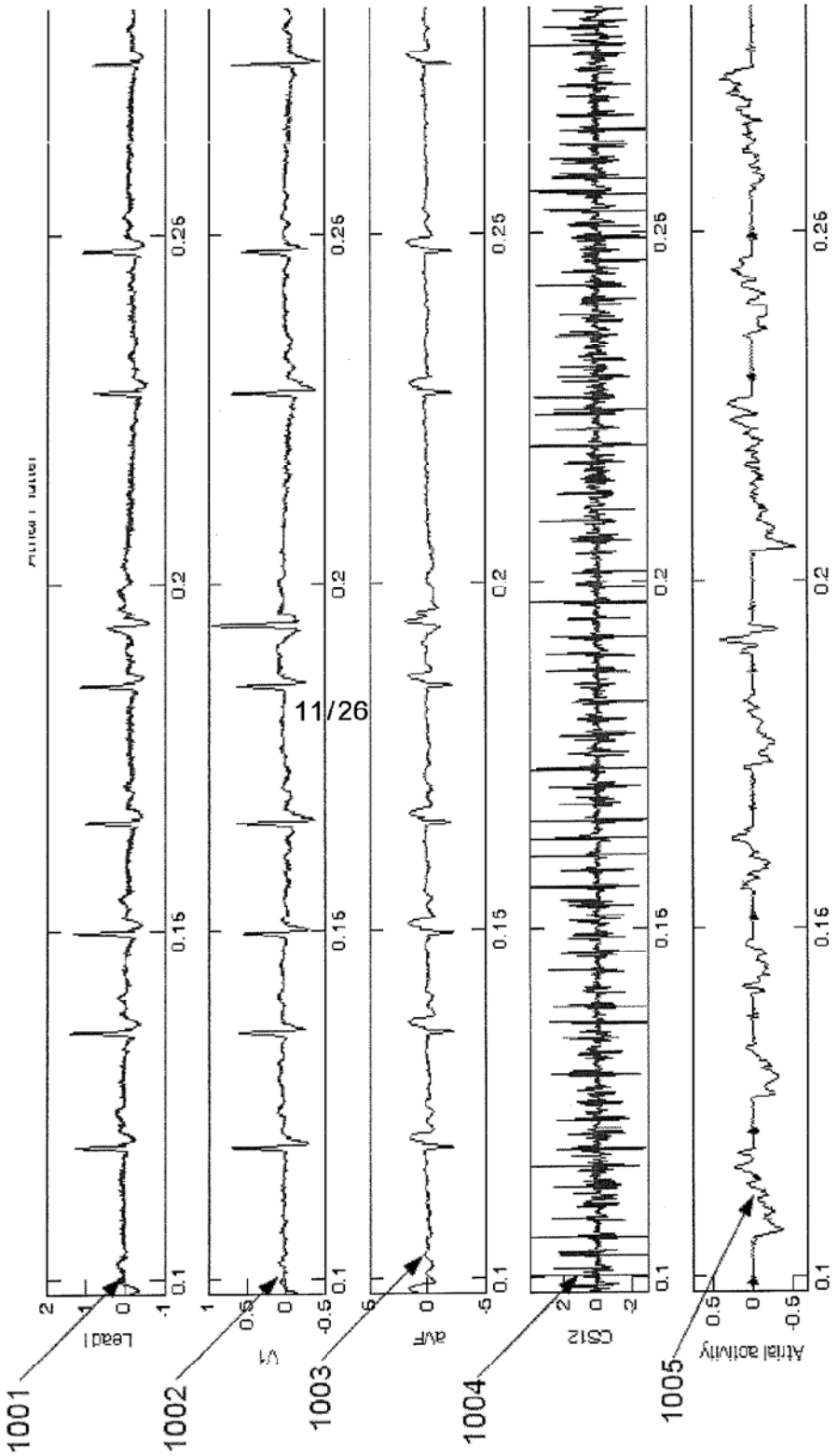


Figure 11
Example of background noise removal from a PNA signal

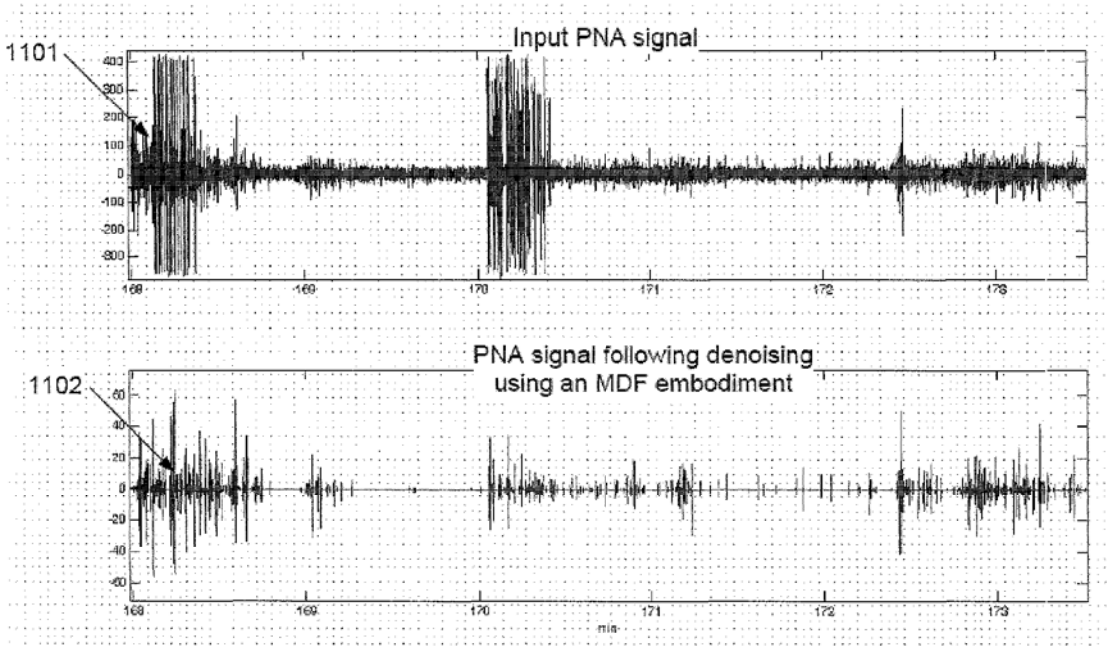


Figure 12
Data flow for computing an emphasis signal of a desired signal wave using an MDSP embodiment and illustrative examples of using emphasis signals of an ECG to find feature points.

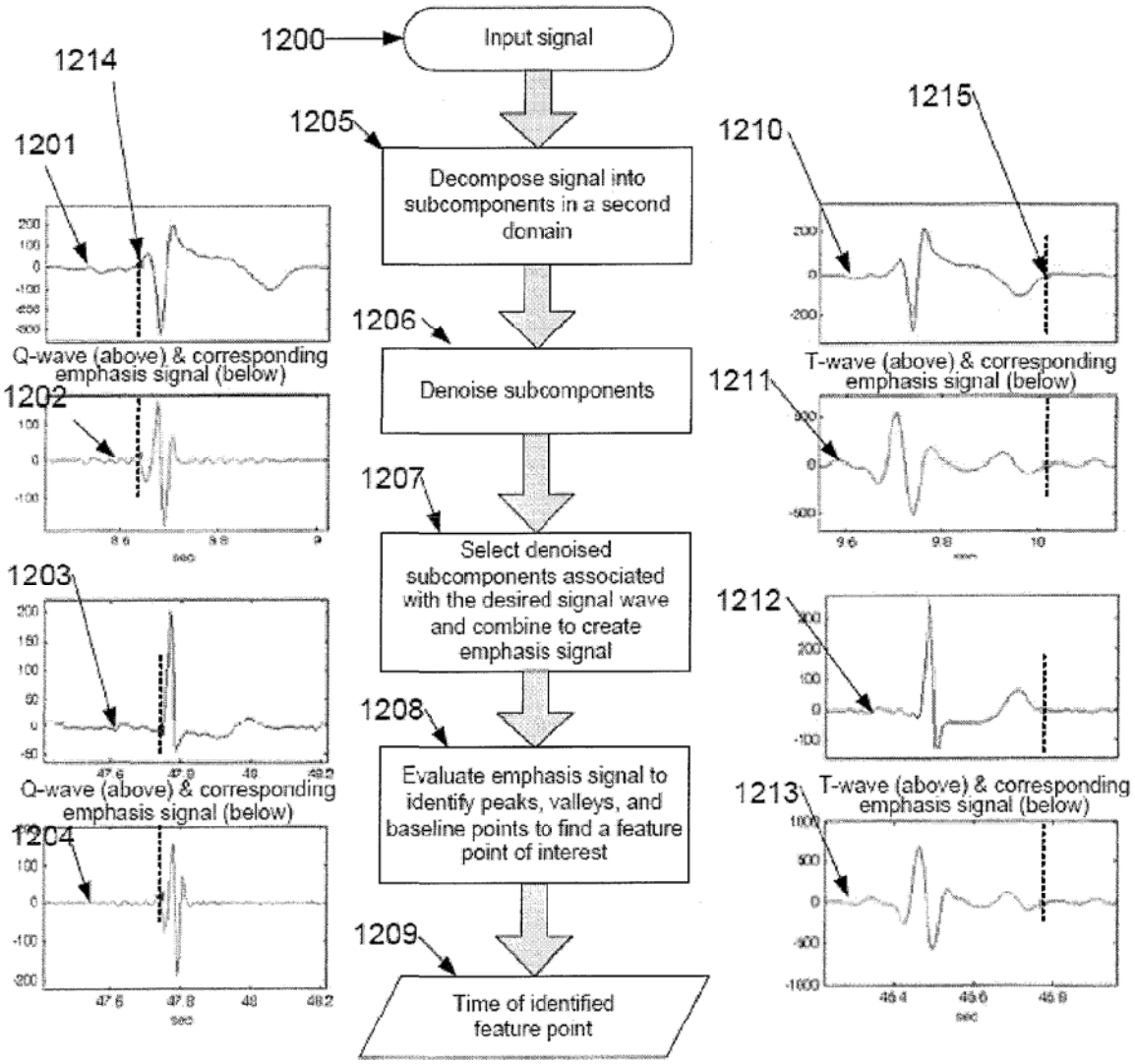


Figure13
QRS detection performance of an MDSP embodiment on a challenging ECG

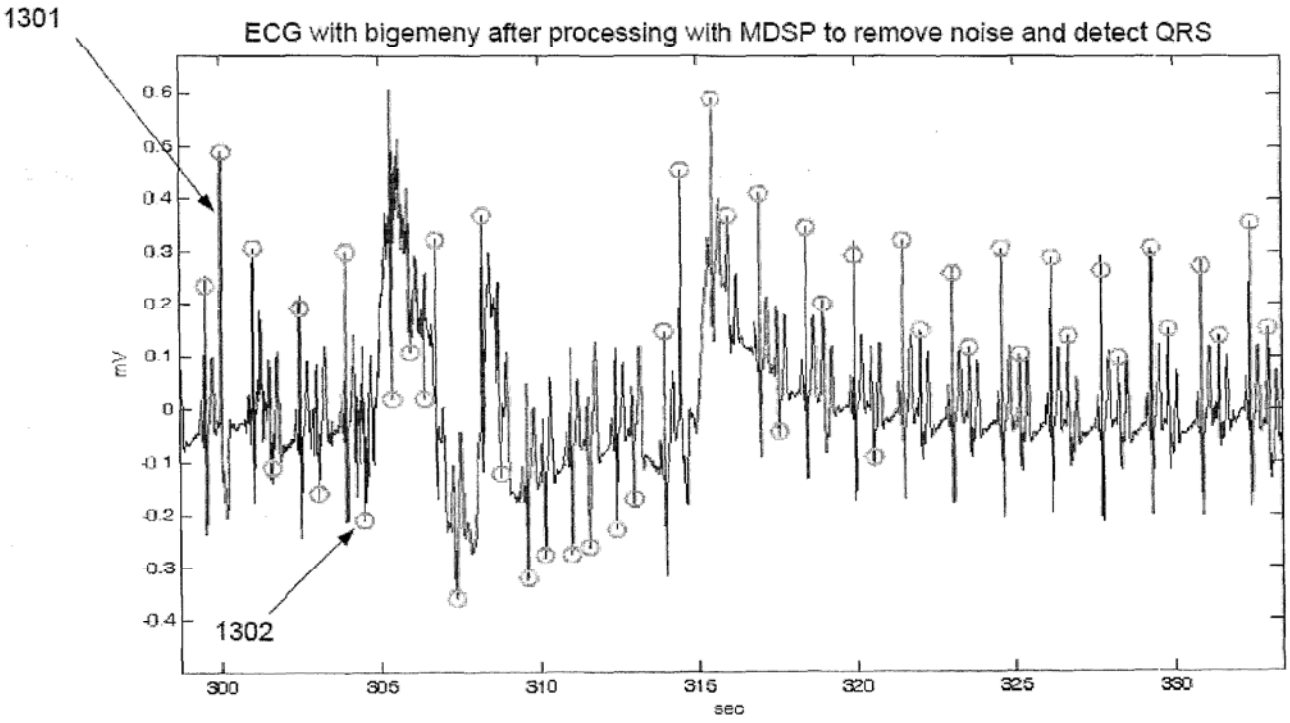


Figure 14

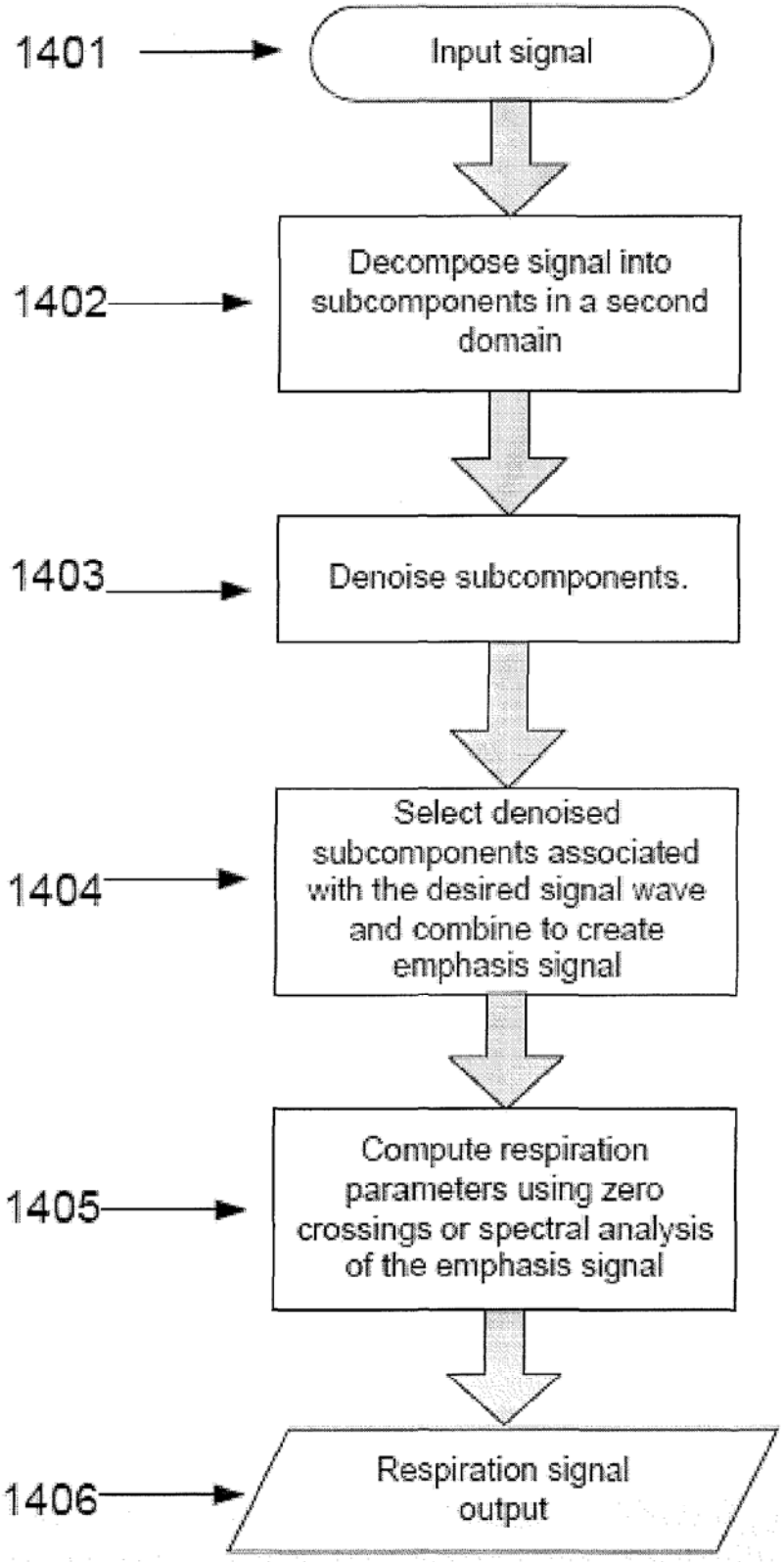

1401
Input signal
1402
Decompose signal into subcomponents in a second domain
1403
Denoise subcomponents.
1404
Select denoised subcomponents associated with the desired signal wave and combine to create emphasis signal
1405
Compute respiration parameters using zero crossings or spectral analysis of the emphasis signal
1406
Respiration signal output

Figure 15
Example of respiration signal derived from an ECG

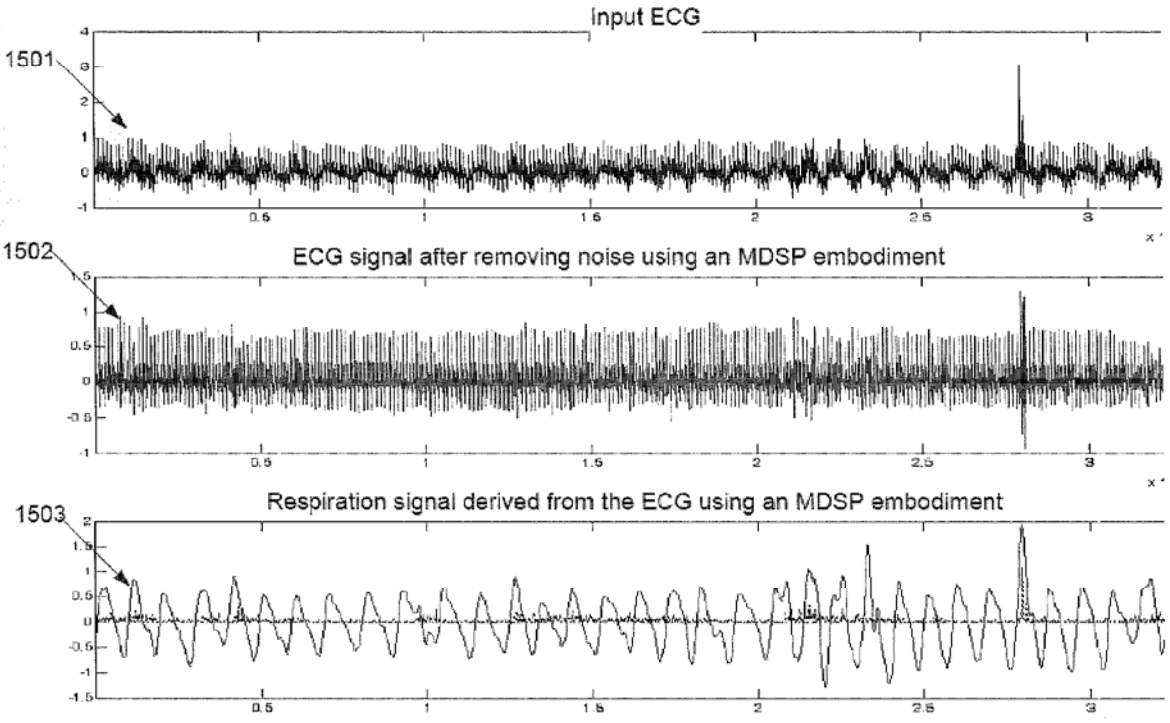


Figure 16

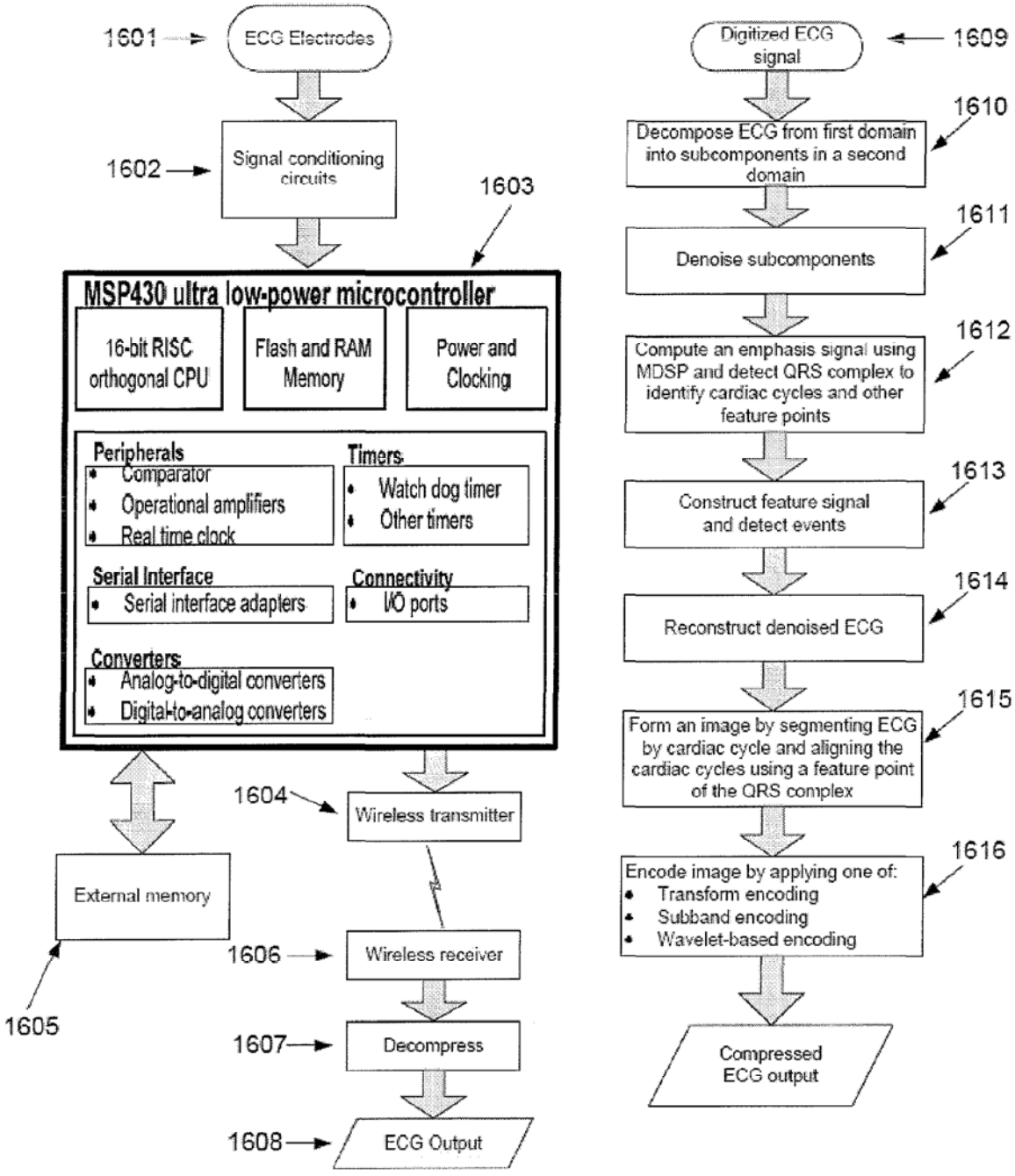

1601
ECG Electrodes
1602
Signal conditioning circuits
1603
MSP430 ultra low-power microcontroller
16-bit RISC orthogonal CPU
Flash and RAM Memory
Power and Clocking
Peripherals
Comparator
Operational amplifiers
Real time clock
Timers
Watch dog timer
Other timers
Serial Interface
Serial interface adapters
Connectivity
I/O ports
Converters
Analog-to-digital converters
Digital-to-analog converters
1604
Wireless transmitter
External memory
1605
1606
Wireless receiver
1607
Decompress
1608
ECG Output
Digitized ECG signal
1609
1610
Decompose ECG from first domain into subcomponents in a second domain
1611
Denoise subcomponents
1612
Compute an emphasis signal using MDSP and detect QRS complex to identify cardiac cycles and other feature points
1613
Construct feature signal and detect events
1614
Reconstruct denoised ECG
1615
Form an image by segmenting ECG by cardiac cycle and aligning the cardiac cycles using a feature point of the QRS complex
1616
Encode image by applying one of:
Transform encoding
Subband encoding
Wavelet-based encoding
Compressed ECG output

Figure 17
Three-dimensional ECG image created as an intermediate step in data compression

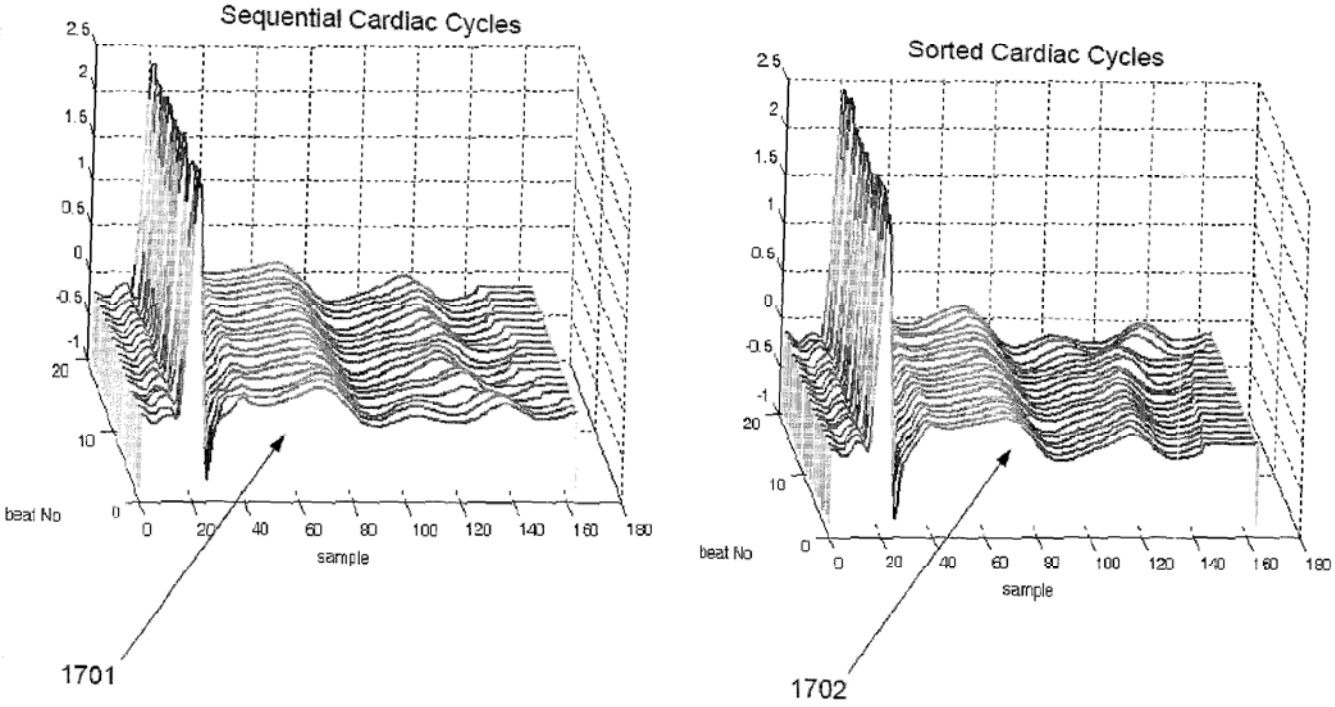


Figure 18
ECG Remote Monitoring System and Rhythm Strip Evaluation Process

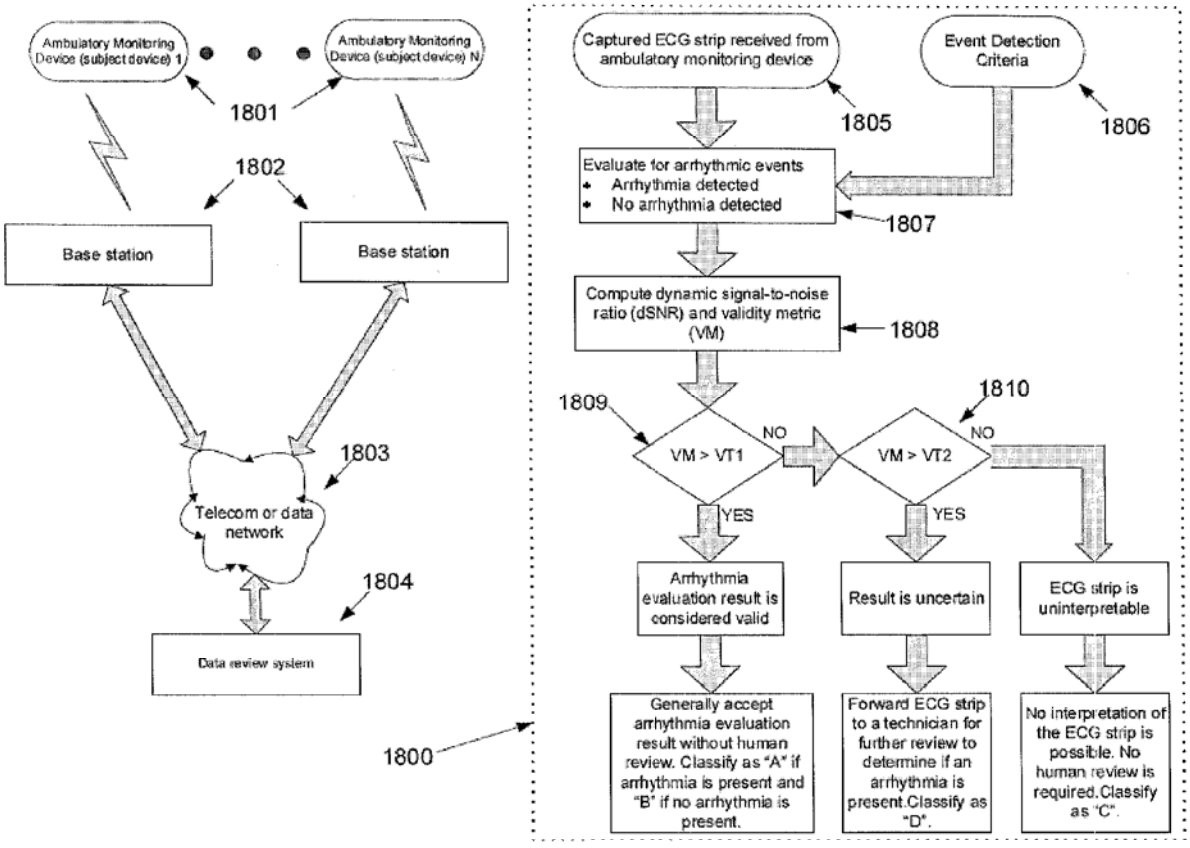


Figure 19
Apparatus for Improving SNR

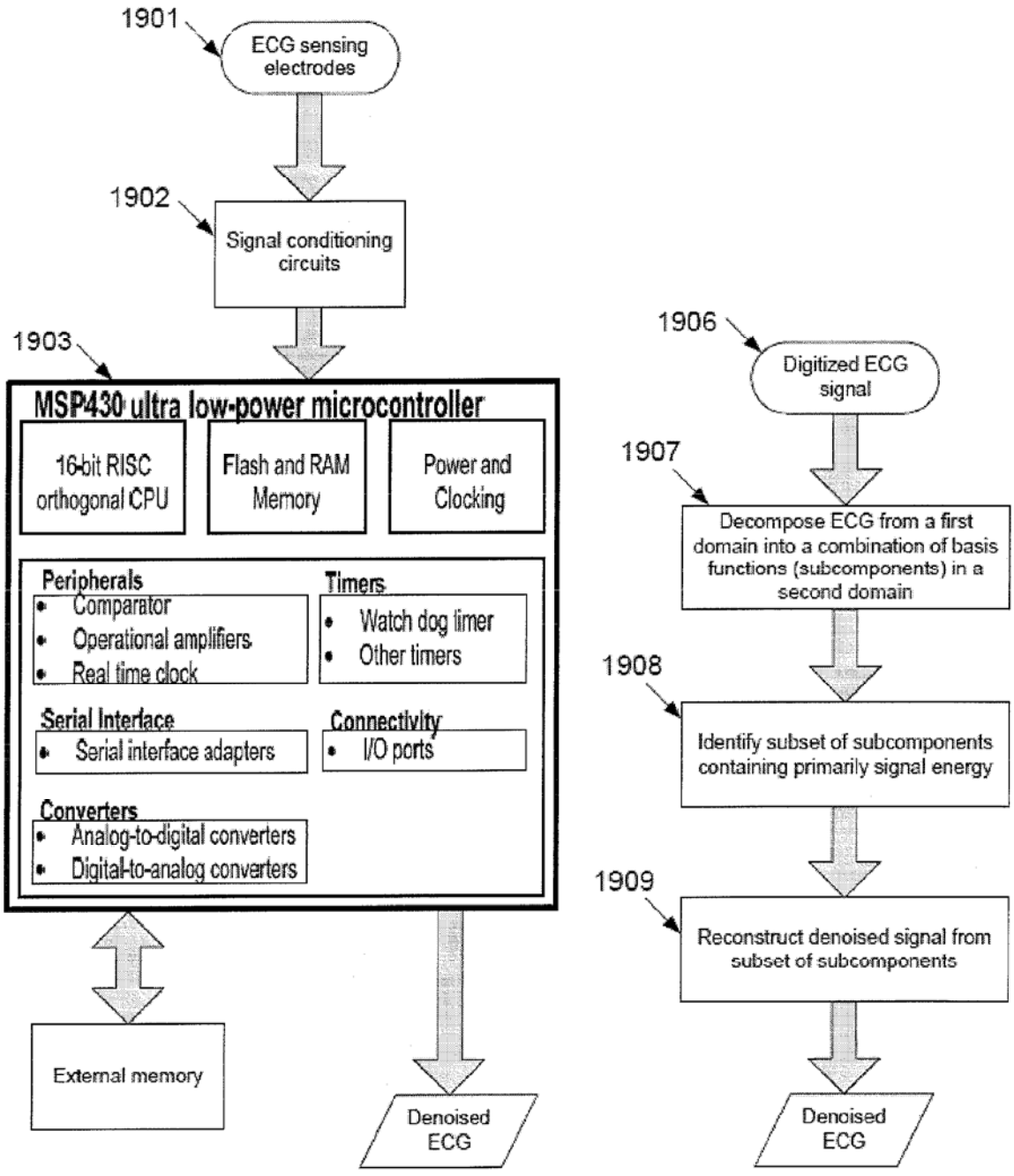


Figure 20

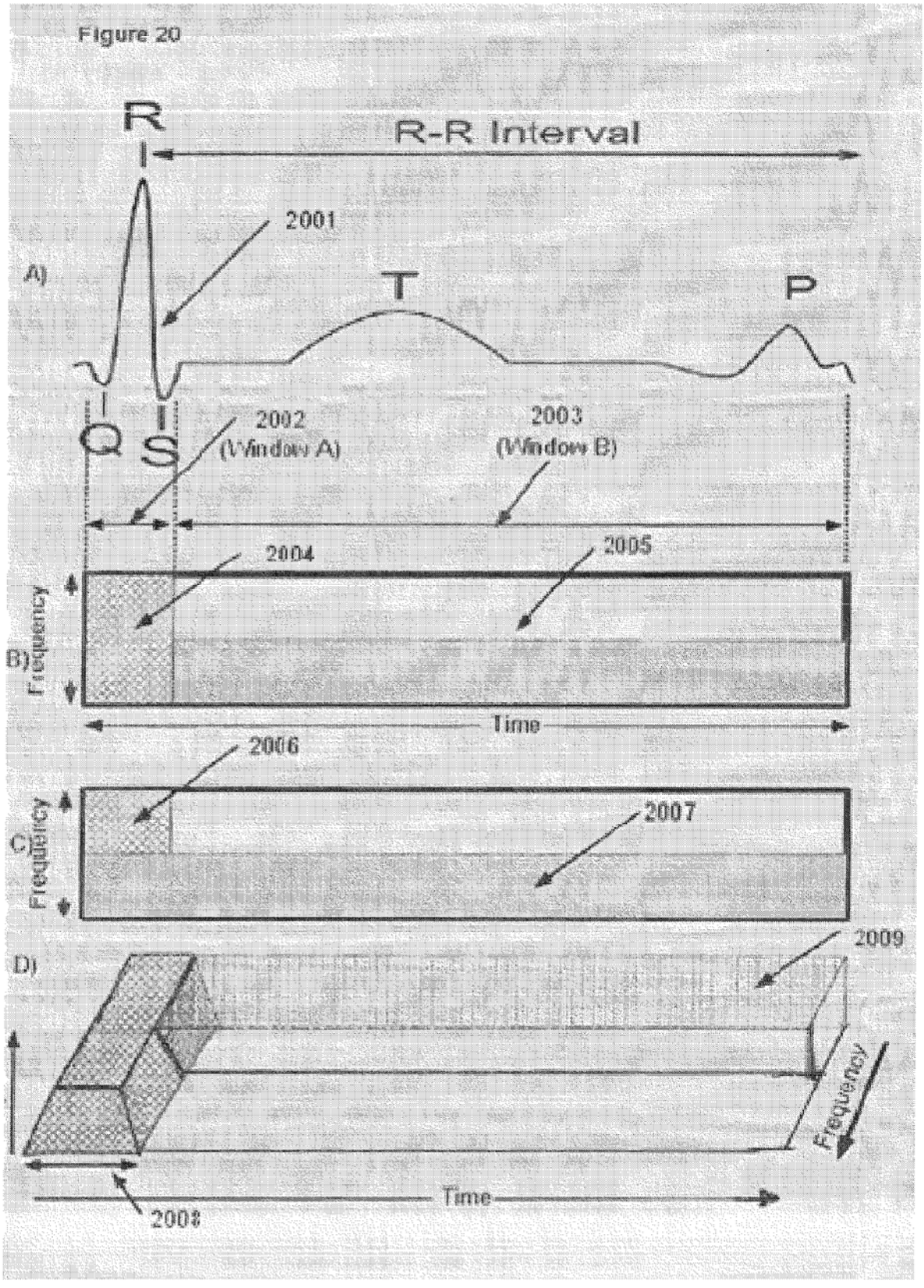
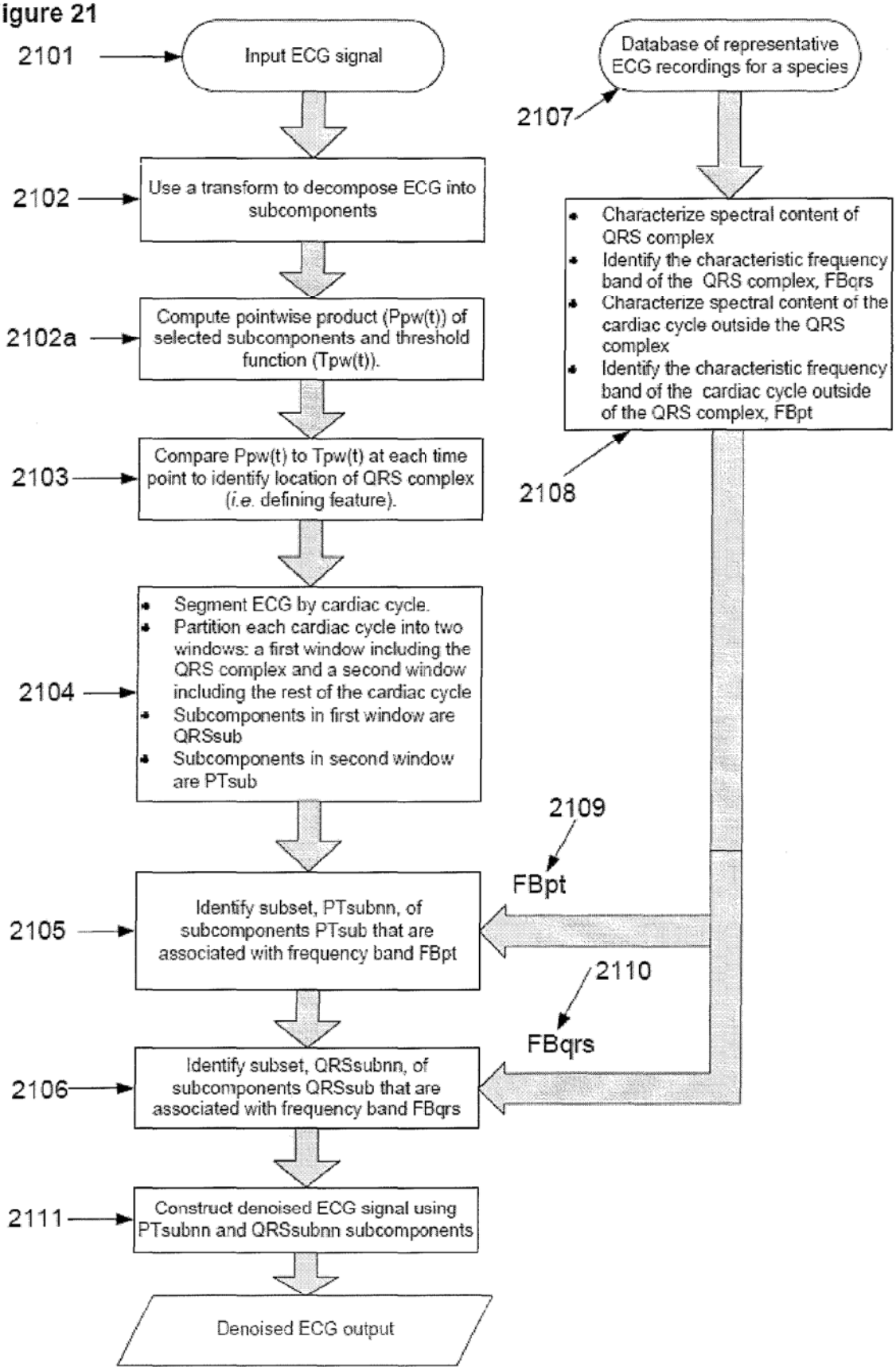

R
R-R Interval
2001
A)
T
P
Q
S
2002
(Window A)
2003
(Window B)
2004
2005
B)
Frequency
Time
2006
2007
C
Frequency
2009
D)
Frequency
Time
2008

Figure 21


2101
Input ECG signal
2102
Use a transform to decompose ECG into subcomponents
2102a
Compute pointwise product (Ppw(t)) of selected subcomponents and threshold function (Tpw(t)).
2103
Compare Ppw(t) to Tpw(t) at each time point to identify location of QRS complex (i.e. defining feature).
2104
Segment ECG by cardiac cycle.
Partition each cardiac cycle into two windows: a first window including the QRS complex and a second window including the rest of the cardiac cycle
Subcomponents in first window are QRSsub
Subcomponents in second window are PTsub
2105
Identify subset, PTsubnn, of subcomponents PTsub that are associated with frequency band FBpt
2106
Identify subset, QRSsubnn, of subcomponents QRSsub that are associated with frequency band FBqrs
2111
Construct denoised ECG signal using PTsubnn and QRSsubnn subcomponents
Denoised ECG output
2107
Database of representative ECG recordings for a species
2108
Characterize spectral content of QRS complex
Identify the characteristic frequency band of the QRS complex, FBqrs
Characterize spectral content of the cardiac cycle outside the QRS complex
Identify the characteristic frequency band of the cardiac cycle outside of the QRS complex, FBpt
2109
FBpt
2110
FBqrs

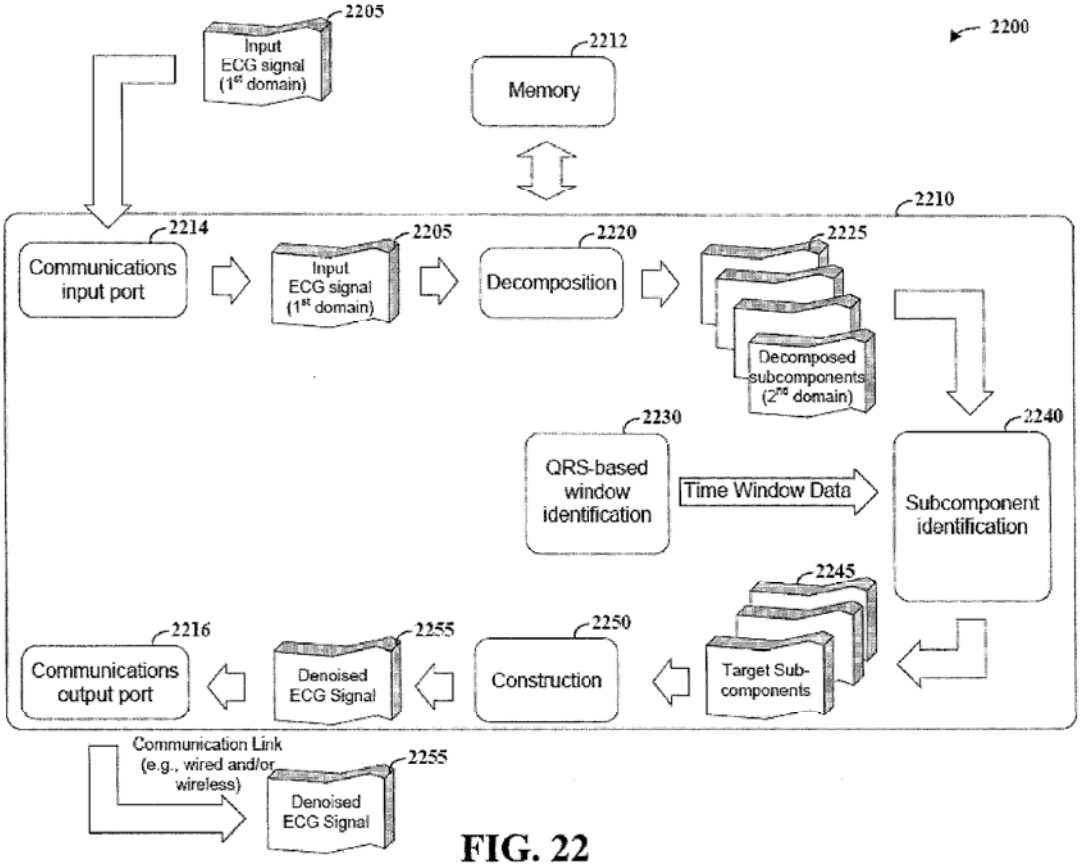

2200
2205
Input ECG signal (1st domain)
2212
Memory
2210
2214
Communications input port
2205
Input ECG signal (1st domain)
2220
Decomposition
2225
Decomposed subcomponents (2nd domain)
2230
QRS-based window identification
Time Window Data
2240
Subcomponent identification
2245
Target Sub-components
2250
Construction
2255
Denoised ECG Signal
2216
Communications output port
Communication Link (e.g., wired and/or wireless)
2255
Denoised ECG Signal

FIG. 22

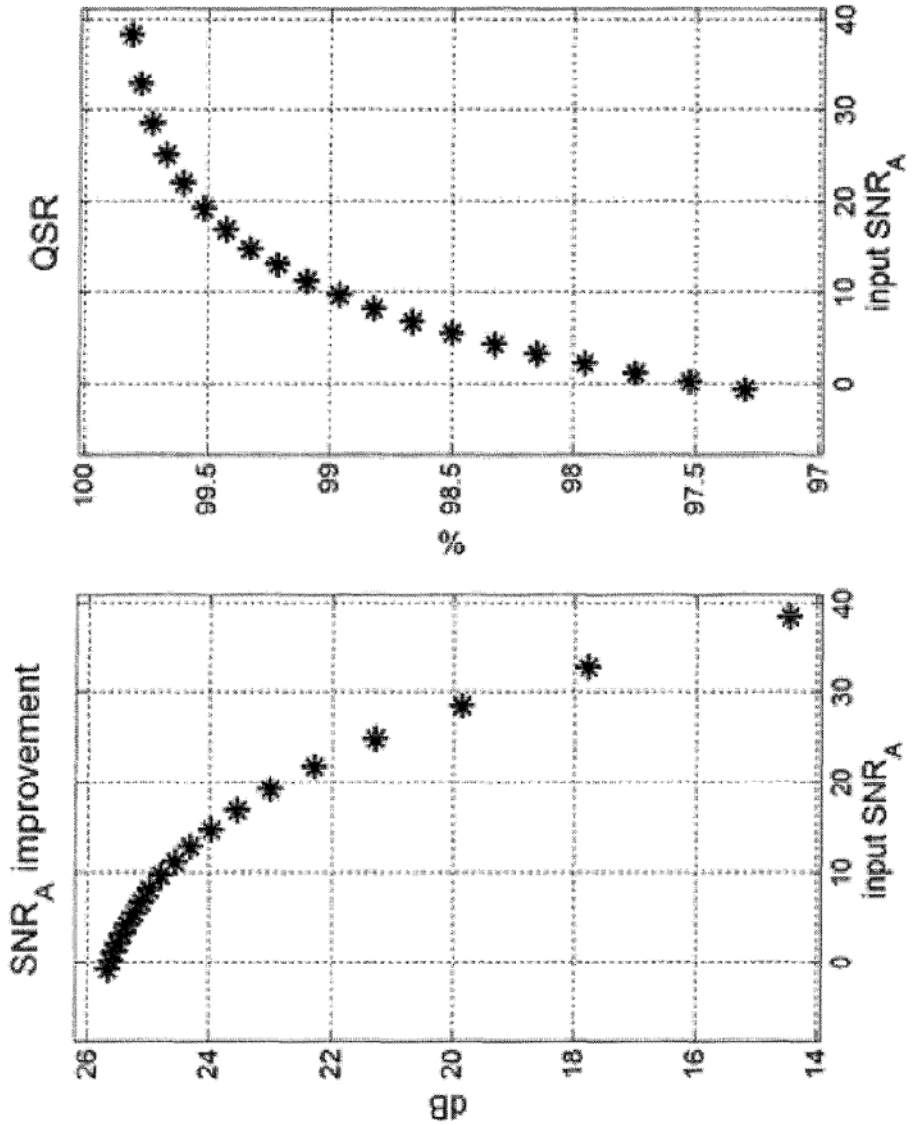

QSR
100
99.5
99
98.5
98
97.5
97
%
0
10
20
30
40
input SNR$_A$
SNR$_A$ improvement
26
24
22
20
18
16
14
dB
0
10
20
30
40
input SNR$_A$

FIG. 23a

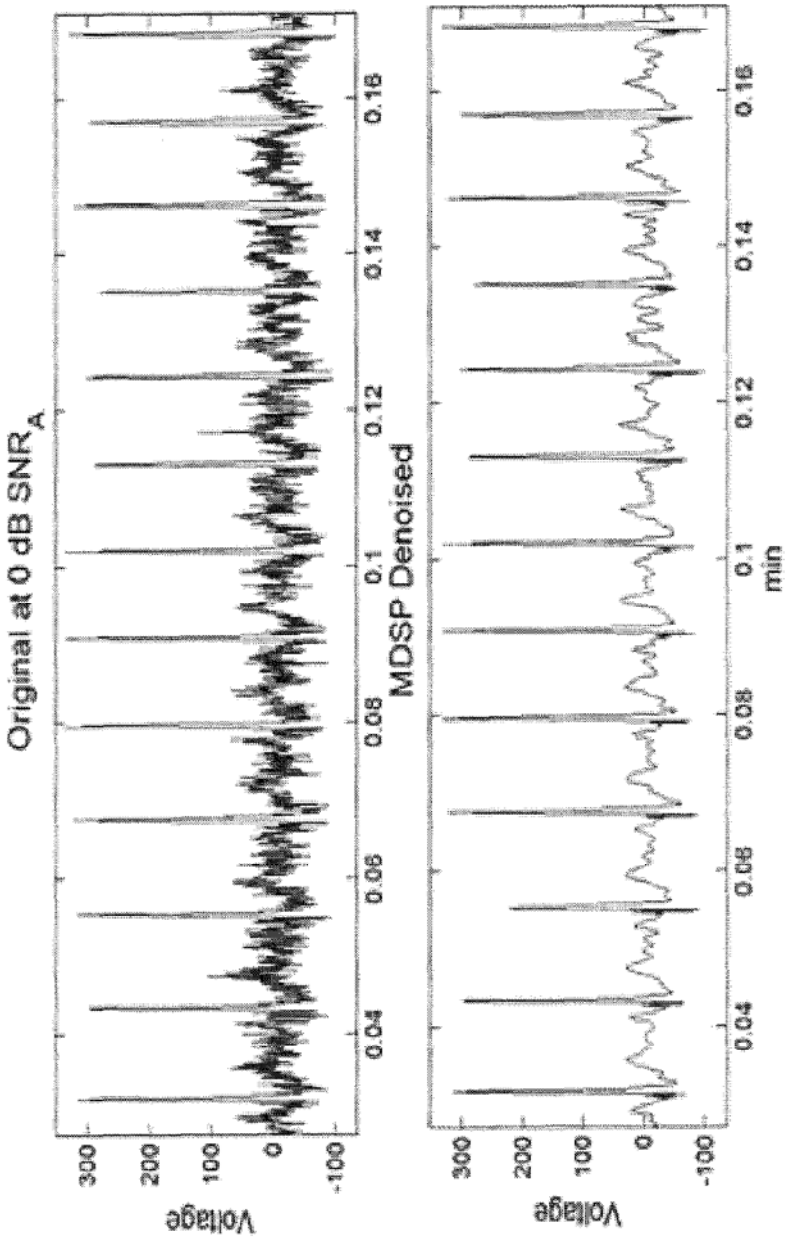

Original at 0 dB SNR_A
MDSP Denoised
Voltage
300
200
100
0
-100
0.04
0.06
0.08
0.1
0.12
0.14
0.16
min

FIG. 23b

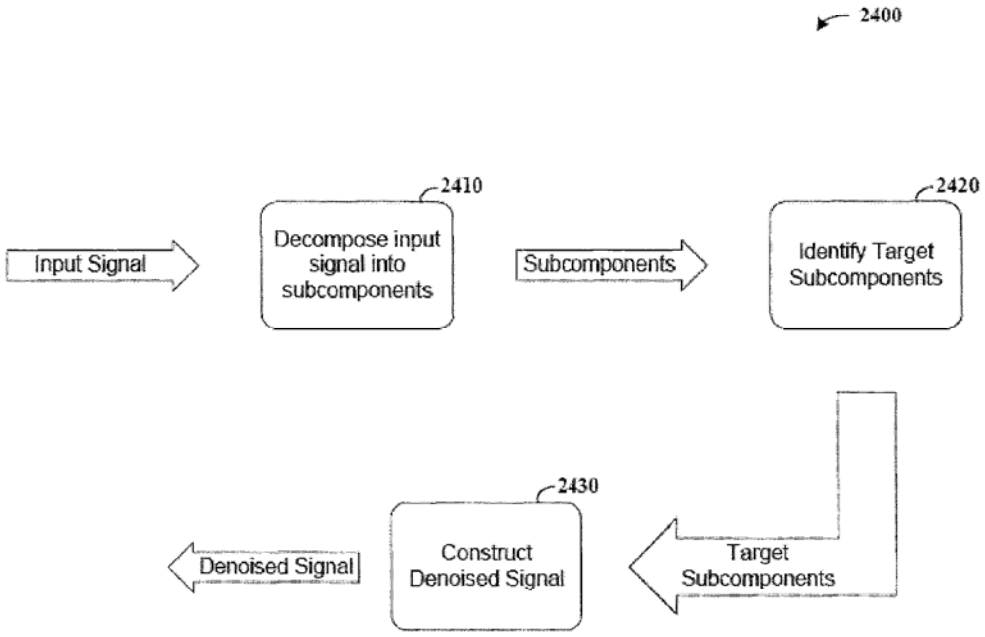

2400
2410
Decompose input signal into subcomponents
2420
Identify Target Subcomponents
Input Signal
Subcomponents
2430
Construct Denoised Signal
Denoised Signal
Target Subcomponents

FIG. 24

Bibliographic Data

Application No: 15/010,345

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /ANDREY SHOSTAK/ (Examiner's Signature) [ ] (Initials)

Title: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/29/2016	600	3735	30210-216
RULE			

APPLICANTS

INVENTORS

Ki H. Chon Worcester, MA, UNITED STATES

Jowoon Chong Worcester, MA, UNITED STATES

Duy Dao Malden, MA, UNITED STATES

Hamed Salehizadeh Worcester, MA, UNITED STATES

CONTINUING DATA

This application has PRO of 62109183 01/29/2015

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

02/24/2016

**** SMALL ENTITY ****

STATE OR COUNTRY

UNITED STATES

ADDRESS

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

FILING FEE RECEIVED

$1,370

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (03-15)
Approved for use through 07/31/2016. OMB 0651-0031
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 contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15010345
Filing Date	2016-01-29
First Named Inventor	Ki H. Chon
Art Unit	3777
Examiner Name	TBD
Attorney Docket Number	30210-216

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					

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

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	20110077484	A1	2011-03-31	Van Slyke et al.	
	2	20080287815	A1	2008-11-20	Chon et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

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	1998042250	WO	A1	2000-02-02	NELLCOR PURITAN BENNETT INC.		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.S./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15010345
Filing Date	2016-01-29
First Named Inventor	Ki H. Chon
Art Unit	3777
Examiner Name	TBD
Attorney Docket Number	30210-216

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	COUCEIRO, R. et al., "Detection of motion artifacts in photoplethysmographic signals based on time and period domain analysis", THE EFFECT OF APPLI ED COMPRESSIVE LOADING ON TISSUE-ENGI NEERED CARTILAGE CONSTRUCTS CULTURED WITH TGF-BETA3, IEEE, 28 August 2012 (2012-08-28), pages 2603-2606.	
	2	SALEHIZADEH, S. et al., "A Novel Time-Varying Spectral Filtering Algorithm for Reconstruction of Motion Artifact Corrupted Heart Rate Signals During Intense Physical Activities Using a Wearable Photoplethysmogram Sensor", SENSORS, vol. 16, no. 1, 23 December 2015 (2015-12-23), page 10.	
	3	The International Search Report And The Written Opinion for PCT/US16/15650 dated May 17, 2016.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/ANDREY SHOSTAK/	Date Considered	09/05/2018

*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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.S./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15010345
Filing Date	2016-01-29
First Named Inventor	Ki H. Chon
Art Unit	3777
Examiner Name	TBD
Attorney Docket Number	30210-216

CERTIFICATION STATEMENT

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

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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)	2016-06-03
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.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.S./

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

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).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /A.S./

Patent Application
Attorney Docket No.: 30210-216

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon | Examiner: SHOSTAK, ANDREY

Application No.: 15/010,345 | Confirm. No.: 2095

Filed: 01-29-2016 | Art Unit: 3735

For: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

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 December 6, 2018 between Orlando Lopez, Applicants' representative, and Examiner Andrey Shiostak and Examiner Navin Natnithithadha.

Claims discussed

1

Prior Art discussed

none

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) 345-3243

Respectfully submitted,

Dated: December 11, 2018 By: /Orlando Lopez/

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

4841-7108-4930.1

Electronic Acknowledgement Receipt

EFS ID:	34548080
Application Number:	15010345
International Application Number:	
Confirmation Number:	2095
Title of Invention:	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Orlando Lopez
Filer Authorized By:	
Attorney Docket Number:	30210-216
Receipt Date:	11-DEC-2018
Filing Date:	29-JAN-2016
Time Stamp:	13:55:02
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		3598_001.pdf	2879932 bad78c6312ccc7dea132cef3542919d8f2d58df7	yes	44

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	14	44
	Claims	4	13
	Amendment/Req. Reconsideration-After Non-Final Reject	1	3

Warnings:					
Information:					
2	Applicant summary of interview with examiner	3599_001.pdf	56298 46ab5b58b41c97c2070402523ee9cdde534ed9c9	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2936230		

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.

REMARKS

The Office Action of has been carefully reviewed, and this response addresses the Examiner's concerns. Applicants respectfully request entry of this amendments into the application.

STATUS OF THE CLAIMS

Claims 1-36 are pending in the application.

Claims 1-36 are rejected.

Claims 7, 8, 10, 11, 13, 14, 24, 25, 27, 28, 30, and 31 are allowable over the prior art.

Claims 2-7, 9, 12, 19-24, 26, and 29 are canceled.

Claim 1 has been amended to include the limitations of claims 2-3 and 6-7. Claim 10 has been amended to include the limitations of claim 9. Claim 13 has been amended in order to render it in independent, including the limitations of all the intervening claims. As in claim 18, has been amended to include the limitations of claims, 19, 20, and 23-24. Claim 25 is amended in order to make it dependent on claim 18. Claim 27 is amended in order to include the limitations of claim 26. Claim 30 is amended in order to render it independent and including the limitations of all of the intervening claims. Claims 35 is amended in order to include the limitations included in amended claim 1.

A

Amendments to the Specification:

The Examiner, in the Office Action, states that :

"The disclosure is objected to because of the following informalities: The use of the terms MASIMO, MASIMO RADICAL, INTEL, XEON, and MATLAB, which are trade names or marks used in commerce, has been noted in this application. They should be (1a) in ALL CAPS or (1b) accompanied by the appropriate symbol (™, SM, or ®) wherever they appear, and be (2) accompanied by the generic terminology. See MPEP 608.01(v).

Although the use of trade names and marks used in commerce (i.e., trademarks, service marks, certification marks, and collective marks) are permissible in patent applications, the

Petitioner Ex-1004, 0237

proprietary nature of the marks should be respected and every effort made to prevent their use in any manner which might adversely affect their validity as commercial marks."

Applicants respectfully state that a search of the Masimo website shows that Masimo does not mark its name as registered and that a search of the USPTO website shows that the Masimo name is only registered as a typed drawing that Masimo Radical is not trademarked (but RADICAL-7 is). Applicants respectfully state that the trademark SET is registered by Masimo and that, in the Masimo website, is referred to as Masimo SET®, as used in the application.

Amendments to paragraphs 28 and 29 of the specification find support in paragraphs 29, 33 and 37 and claims 10, 12, 14, 16 and 18 of U.S. Published application 2012190947, which is incorporated by reference in the present application.

CLAIM OBJECTIONS

Claim 5 is objected to because of the following informalities: the recitation of "Mahine" is a typographical error and should instead read --Machine--. Appropriate correction is required.

CLAIM REJECTIONS - 35 USC § 112

Claims 1-36 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

The test for definiteness under 35 U.S.C. § 112, second paragraph, is whether "those skilled in the art would understand what is claimed when the claim is read in light of the specification." *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576 (Fed. Cir. 1986); MPEP 2173.02.

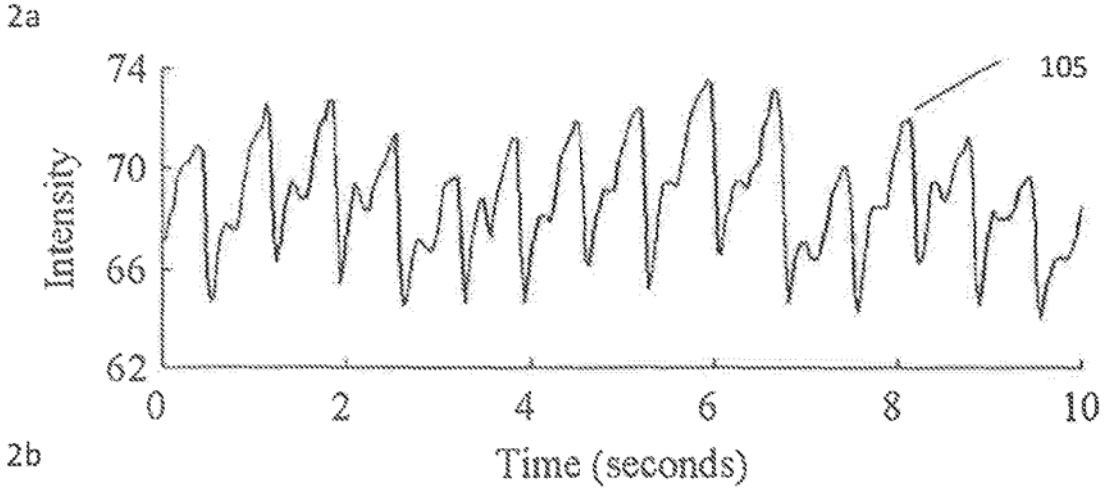
The examiner, in the office action, states that "**Regarding claims 1, 9, 12, 15, 16, 18, 26, 29, 32, 33, and 35,** they each recite "equivalent signal," which is a relative phrase which renders the claim indefinite. The phrase "equivalent signal" is not defined by the claim, the specification

Petitioner Ex-1004, 0238

does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Specifically, it is unclear what kind of signal would be considered an equivalent. ¶ 0028 of the specification defines them as signals which behave like PPG signals, but it is unclear what behavior/signal qualities are intended or encompassed."

Applicants respectfully state that an example of what are equivalent signals is provided in paragraph 81 of the specification, which states "The capability to extract accurate PPG equivalent signals, HR signals, heart rate variability dynamics, the respiratory rates and oxygen saturation information directly from the green, red, and blue band signals from a smart phone is detailed in a recently published paper (see also PCT Publication No. WO2012100175, corresponding to PCT/US2012/022049, PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE, filed on January 20, 2012, and corresponding U.S. Published application 2012190947, PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE, which are incorporated by reference herein in their entirety and for all purposes)."

In paragraph 79 of , U.S. Published application 2012190947, it is stated that "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." Fig. 2a is reproduced below:



The above is a reflective PPG signal. The typical PPG signal is a transmissive PPG signal.

Applicants respectfully state that one skilled in the art, upon being in the specification, would know what is claimed by "equivalent to PPG signals" and would know what "behaving as a PPG signal" entails.
Applicants have amended the claims to state "signals used as PPG signals," which has support in paragraph 81 of the specification.

Regarding claims 3, 6, 9, 12, 20, 23, 26, and 29, the Examiner states that "they each recite "hereinafter referred to as" or "referred to as," which are narrative recitations that fail to particularly point out the invention at least because reference is made to subsequent claims. The terms should be defined first.

Claims 3, 6, 9, 12, 20, 23, 26 and 29 have been canceled. The recitation of hereinafter referred to as now occurs in the midst of the claim so that the reference is not made to a subsequent claim.

Regarding claims 1, 3, 6, 7, 9, 10, 12, 13, 18, 20, 23, 24, 26, 27, 29, 30, and 35, the Examiner states that "the separation and interoperability of elements is unclear because the claims use a

Petitioner Ex-1004, 0240

semicolon, instead of e.g. a comma, to further detail particular elements (see e.g. line 5 of claim 1). Is the semicolon intended to introduce a new step, or to further limit a detail of a previous step?"

Applicants respectfully state that the only rule stated in the rules and the MPEP is that a claim is a single sentence. The use of semicolons and sentences is well accepted in grammar (see, for example, Margaret Shertzer, The Elements of Grammar, pp. 88-90, C. Edward Good, A grammar Book for You and I (ops, Me), pp. 378-380, Karen Elizabeth Gordon, The Deluxe Transitive Vampire, p. 160, copies of which are enclosed in the appendix). Examples of the use of semi-colons in claims can be found in the claims of the cited art, US Patent Application Publication 2011/0077484, US Patent 5,853,364 ("Baker") and International Application Publication WO 2013/043157 ("Brockway").
Since; semi-colons have been used in these claims, both for independent clauses and for separating elements in a series (both of which are acceptable, according to grammar), we have a good indication of how the courts will interpret (construe) the claims. The effect of a comma in claim interpretation can be seen in 3Form, Inc. v. Lumicore, Inc. (Fed. Cir. 2015, nonprecedential).

Applicants respectfully state that, since those skilled in the art would understand what is claimed when the claim is read in light of the specification, the claims are definite.

Regarding claims 1, 18, and 35, the Examiner states that "the second recitation of "a segment" makes it unclear whether this is the same as, or different than, the segment contemplated by the first recitation of "a segment.""
Applicants have amended the claims.

Regarding claims 3 and 20, the Examiner states that "the second and third recitations of "a narrow band spectrum" make it unclear whether they are the same as, or different than, the narrow band spectrum contemplated by the first recitation of "a narrow band spectrum.""

Petitioner Ex-1004, 0241

Applicants have amended the claims in order to make them definite.

Regarding claim 19, the Examiner states that "the recitation of "a noise quality index" in line 1 makes it unclear whether this is the same as, or different than, the noise quality index already introduced in claim 18"
Applicants respectfully state that the amended claims are definite.

Regarding claim 35, the Examiner states that "there is insufficient antecedent basis for the recitation of "the one or more processors" in line 3."

Applicants have amended the claim in order to make it definite.

THE 35 U.S.C. 101 REJECTIONS

Claims 1-36 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more.

As stated in the specification, extraction of the above mentioned vital signs and other physiological parameters using Pulse Oximeters is predicated on artifact-free PPG data. It is well known that the PPG is highly sensitive to artifacts, particularly those generated while the patient is in motion (Petterson, M. T., V. L. Begnoche, and J. M. Graybeal. The effect of motion on pulse oximetry and its clinical significance. *Anesth. Analg.* 105:S78–84, 2007). This imposes a huge limitation on the usability of the PPG for ambulatory monitoring applications. Motion and noise artifacts (MNAs) distorting PPG recordings can cause erroneous estimation of HR and SpO2 (Sahni, R., A. Gupta, K. Ohira-Kist, and T. Rosen. Motion resistant pulse oximetry in neonates. *Arch. Dis. Child. Fetal Neonatal Ed.* 88:F505–F508, 2003).

Although there are techniques which have been proposed to alleviate the effects of MNA, solutions to this problem still remain unsatisfactory in practice. Several algorithm-based MNA reduction methods have been proposed, such as time and frequency domain filtering, power spectrum analysis, and blind source separation techniques. These techniques reconstruct noise

Petitioner Ex-1004, 0242

contaminated PPG such that a noise-reduced signal is obtained. However, the reconstructed signal typically contains incomplete dynamic features of the uncorrupted PPG signal and some algorithms are solely designed to capture only the HR and SpO2 information instead of the signal's morphology and its amplitudes, which are needed for other physiological derivations. Moreover, these reconstruction algorithms operate even on clean PPG portions where MNA reduction is not needed. This introduces unnecessary computation burden and distorts the signal integrity of the clean portion of the data. Hence, an accurate MNA detection algorithm, which identifies clean PPG recordings from corrupted portions, is essential for the subsequent MNA reduction algorithm so that it does not distort the non-corrupted data segments (Krishnan, R., B. Natarajan, and S. Warren. Two-Stage Approach for Detection and Reduction of Motion Artifacts in Photoplethysmographic Data. *IEEE Trans. Biomed. Eng.* 57:1867– 1876, 2010)..

The method and system of these teachings solve the above stated problems with the present techniques. The present techniques was compared with three other recently published MNA detection algorithms: 1) Hjorth features (Hjorth), 2) time-domain variability SVM (TDV-SVM) approach, and 3) Kurtosis-Shannon Entropy (KSE) features. Performance results of each method are presented in Table II, reproduced below , and show that the present invention outperforms the other MNA detection techniques while avoiding the problems of distortion of the non-corrupted data.

Petitioner Ex-1004, 0243

TABLE II. MEAN ± STD. DEVIATION OF PERFORMANCE METRICS OF THE PRESENT VFCDM, OTHER METHODS

		VFCDM	Hjorth		TDV		KSE	
Lab. Head	Acc	96.9 ± 1.4	72.5 ± 10.7	*	93.4 ± 3.5	*	83.1 ± 7.3	*
	Sen	96.3 ± 2.4	47.2 ± 28.8	*	88.8 ± 7.9	*	56.6 ± 17.9	*
	Spe	97.7 ± 2.0	84.4 ± 4.6	*	96.7 ± 3.0		91.5 ± 1.1	*
Umass. Head	Acc	95.5 ± 2.2	69.5 ± 21.8	*	89.8 ± 1.4	*	85.1 ± 8.3	*
	Sen	91.1 ± 3.5	53.8 ± 26.1	*	84.6 ± 2.9	*	68.7 ± 17.7	*
	Spe	96.3 ± 1.4	84.5 ± 8.8	*	94.3 ± 4.0		86.4 ± 7.8	*
Lab. Finger	Acc	97.7 ± 1.4	91.1 ± 6.9	*	94.4 ± 3.3	*	58.5 ± 20.7	*
	Sen	96.3 ± 2.6	83.5 ± 21.0	*	94.7 ± 3.4		34.6 ± 12.2	*
	Spe	98.2 ± 1.4	96.2 ± 3.0		94.7 ± 3.0	*	86.3 ± 15.7	*
Umass. Finger	Acc	95.5 ± 2.4	71.0 ± 19.0	*	89.6 ± 2.3	*	88.3 ± 2.7	*
	Sen	89.2 ± 2.0	41.1 ± 27.6	*	85.2 ± 3.8	*	71.5 ± 8.8	*
	Spe	97.2 ± 2.1	88.4 ± 7.5	*	95.1 ± 0.8		93.6 ± 1.5	*

(*) indicate statistical significance ($p<0.01$) between the present method versus the others

[0001] Accurate detection of the start and end time of the MNA is important for the subsequent reconstruction of the MNA-corrupted data in order not to miss the MNA portion of data for reconstruction or avoid having to reconstruct the noisy portion of the PPG signal when the data segment is designated to be clean. To evaluate the algorithm's effectiveness in pinpointing the start and end time of the MNA, the time difference of start and end points was computed between the visual reference and detection algorithms' results. The time difference is termed detection transition time, DTT, which reflects how accurate on average the MNA algorithm detects the start and end time of the MNA. Table III provides DTT comparison of the VFCDM algorithm and other detection algorithms. As shown in Table III, the algorithm's detection accuracy of the duration of the MNA is significantly better than three other methods compared. The algorithm is off by less than 1 second whereas the second best algorithm, the Hjorth, is off by more than 2 seconds and the least accurate method, the KSE, is off by more than 4 seconds.

Petitioner Ex-1004, 0244

TABLE III. MEAN ± STD. DETECTION OF TRANSITION TIME, DTT OF THE VFCDM METHOD AND OTHER METHODS.

Algorithm	DTT (sec)
VFCDM	0.94 ± 0.65
Hjorth	2.17 ± 0.37 *
KSE	4.24 ± 2.42 *
TDV	2.75 ± 0.96 *

(*) indicate statistical significance ($p<0.01$) between the present method versus the others

The present invention solves the problems brought about by the effect of motion on the use of PPG signals and does not distortion of the non-corrupted data. The present invention enables the use of PPG for ambulatory monitoring applications.

Section 101 permits the patenting of "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof." 35 U.S.C. § 101. The Supreme Court has interpreted Section 101 to contain "an important implicit exception: Laws of nature, natural phenomena, and abstract ideas are not patentable." *Alice Corp. v. CLS Bank Int'l*, 134 S. Ct. 2347, 2354 (2014) (quoting *Ass'n for Molecular Pathology v. Myriad Genetics*, Inc., 133 S. Ct. 2107, 2116 (2013)).
In *Mayo* and in *Alice*, the Supreme Court set forth a two-step analytical framework to identify patents that, in essence, claim nothing more than abstract ideas. The court must first "determine whether the claims at issue are directed to a patent-ineligible concept." *Alice*, 134 S.Ct. at 2355. If it is determined that the claims are directed to a patent ineligible concept, the analysis proceeds to step two where one must "consider the elements of each claim both individually and 'as an ordered combination' to determine whether the additional elements 'transform the nature of the claim' into a patent-eligible application." *Id.*(quoting *Mayo*, 132 S. Ct. at 1298, 1297).

Step one

Starting with step one, as stated in *Alice* and as the Federal Circuit has stated in *Enfish, Rapid Litigation* and *McRo*, the inquiry should be whether the claims are directed a judicial exception.

Petitioner Ex-1004, 0245

The directed to inquiry is based on whether the character of the claim as a whole is directed to a judicial exception (focus of the claimed advance over the prior art). *Enfish, LLC v. Microsoft Corp,* 822 F.3d 1327 (Fed. Cir. 2016); *Rapid Litigation Management v. CellzDirect*, 827 F.3d 1042, 1048 (Fed. Cir. 2016); *Mcro, Inc. v. Bandai Namco Games America,* 837 F.3d 1299 (Fed. Cir. 2016). The inquiry under step one looks to whether the claims focus on a specific means or method that improves the relevant technology or are instead directed to a result or effect that itself is the abstract idea and merely invoke generic processes and machinery. *Enfish,* 822 F.3d at 1336; *Rapid Litig. Mgmt.,* 827 F.3d at 1048; as cited in *McRo,* 837 F.3d 1299 (Fed. Cir. 2016).

The claimed invention is directed to solving the problems brought about by the effect of motion on the use of PPG signals and does not distort the non-corrupted data and to enabling the use of PPG for ambulatory monitoring applications. The Applicants' claimed invention does not attempt to patent a mathematical formula.

Although the Supreme Court has not established a definitive rule to determine what constitutes an "abstract idea," both the Federal Circuit and the Supreme Court have found it sufficient to compare claims at issue to those claims already found to be directed to an abstract idea in previous cases. *Enfish,* 822 F.3d at 1334 (citing *Alice*, 134 S.Ct. at 2357).

The Examiner, in the Office Action, states that "This idea is similar to the basic concept of manipulating information from source devices using mathematical relationships (e.g. creating device profiles based on processed information, using known mathematical techniques), such as in Digitech Image Techs., LLC v Electronics for Imaging, Inc., 758 F.3d 1244, 111 U.S.P.Q.2d 1717 (Fed. Cir. 2014), which has been found by the courts to be an abstract idea."

In *Digitech,* "Claim 10 describes the process for generating the device profile:

> 10. A method of generating a device profile that describes properties of a device in a digital image reproduction system for capturing, transforming or rendering an image, said method comprising:
>
> generating first data for describing a device dependent transformation of color information content of the image to a device independent color

Petitioner Ex-1004, 0246

> space through use of measured chromatic stimuli and device response characteristic functions;
>
> generating second data for describing a device dependent transformation of spatial information content of the image in said device independent color space through use of spatial stimuli and device response characteristic functions; and
>
> combining said first and second data into the device profile."

Digitech, 758 F.3d at 1350-1351. The Court had found that the device profile "as claimed, is a collection of intangible color and spatial information" and held "that the device profile claims of the '415 patent do not encompass eligible subject matter as required by section 101 and are therefore not patent eligible." *Digitech*, 758 F.3d at 1350. The Court states that "The above claim recites a process of taking two data sets and combining them into a single data set, the device profile. The two data sets are generated by taking existing information--*i.e.*, measured chromatic stimuli, spatial stimuli, and device response characteristic functions--and organizing this information into a new form. The above claim thus recites an ineligible abstract process of gathering and combining data that does not require input from a physical device. As discussed above, the two data sets and the resulting device profile are ineligible subject matter."

During the interview, the examiner made reference to SAP AMERICA, INC. v. INVESTPIC, LLC, 890 F.3d 1016 (Fed. Cir. 2018). As the Federal Circuit stated, in *SAP America*, the subject matter of the claims is " is nothing but a series of mathematical calculations based on selected information and the presentation of the results of those calculations (in the plot of a probability distribution function). *SAP America*, 758 F. 3d at 1018.

In contrast, the present claim starts with a Photoplethysmogram (PPG) or equivalent signal and is directed to determining whether segments of the signal are corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts. The corrupted segments can then be removed. The present invention solves the problems brought about by the effect of motion on the use of PPG signals and the distortion of the non-corrupted data. The present invention enables the use of PPG for ambulatory monitoring applications.

Petitioner Ex-1004, 0247

Although the specification is very articulate about the use of the present invention, Applicants have amended the claims in order to draft him as a method for physiological parameter monitoring. As defined in the specification, physiological parameters include heart rate and heart rate variability, respiratory rate, a measure of oxygen saturation, a measure of blood loss, and a measure of atrial fibrillation. A person would not want their measure of atrial fibrillation to indicate the presence of atrial fibrillation when there is no atrial fibrillation or to indicate the absence of atrial fibrillation when there is actual atrial fibrillation. The present invention prevents errors caused by motion and noise artifacts from causing such problems.

Since the present claim starts with a Photoplethysmogram (PPG) or equivalent signal and is directed to removing the limitations on the use of PPG for ambulatory monitoring applications and the erroneous estimation of HR and SpO2 caused by corrupted data. The present claims have definite applications and provides improvements in the use of PPG data.

Applicants respectfully state that the present claims are more similar to the claims in *Research Corporation Technologies, Inc. v. Microsoft Corp.*, 627 F.3d 859 (Fed. Cir. 2010). In *Research Corporation Technologies,* the claims recited a mathematical operation of utilizing a blue noise mask for halftoning of gray scale images. For example, claim 1 of the '310 patent recites:

"A method for the halftoning of gray scale images by utilizing a pixel-by-pixel comparison of the image against a blue noise mask in which the blue noise mask is comprised of a random non-deterministic, non-white noise single valued function which is designed to produce visually pleasing dot profiles when thresholded at any level of said gray scale images." *Research Corporation*, 627 F.3d at 865.

In finding the claims to be patent eligible, the Court states that "These inventions address "a need in the art for a method of and apparatus for the halftone rendering of gray scale images in which a digital data processor is utilized in a simple and precise manner to accomplish the halftone rendering."" The Court also states that "inventions with specific applications or improvements to

Petitioner Ex-1004, 0248

technologies in the marketplace are not likely to be so abstract that they override the statutory language and framework of the Patent Act."" *Research Corporation*, 627 F.3d at 868-869.

As the Federal Circuit stated in SAP America, the present claims are similar to the claims in *McRO, Inc. v. Bandai Namco Games America Inc.*, 837 F.3d 1299 (Fed. Cir. 2016). "The claims in *McRO* were directed to the creation of something physical—– namely, the display of "lip synchronization and facial expressions" of animated characters on screens for viewing by human eyes. *Id.* at 1313. The claimed improvement was to how the physical display operated (to produce better quality images), unlike (what is present here) a claimed improvement in a mathematical technique with no improved display mechanism." *SAP America*, 758 F. 3d at 1021.

Similarly, the present claimed invention has specific applications and improvements in the use of PPG data in physiological parameter measurement.

As the Federal Circuit stated in SAP America, the present claims are similar to the claims in *McRO, Inc. v. Bandai Namco Games America Inc.*, 837 F.3d 1299 (Fed. Cir. 2016). "The claims in *McRO* were directed to the creation of something physical—– namely, the display of "lip synchronization and facial expressions" of animated characters on screens for viewing by human eyes. *Id.* at 1313. The claimed improvement was to how the physical display operated (to produce better quality images), unlike (what is present here) a claimed improvement in a mathematical technique with no improved display mechanism."

Similarly, the present claimed invention has specific applications and improvements in the use of PPG data in physiological parameter measurement where the output is a heart rate, oxygen saturation in blood, blood loss, or the measurement of atrial fibrillation.

The present claims are similar to the claims in *Thales Visionix Inc. v. United States*, 850 F.3d 1343, 1348–49 (Fed. Cir. 2017), where "the improvement was in a physical tracking system. The use of mathematics to achieve an improvement no more changed the conclusion that improved physical things and actions were the subject of the claimed advance than it did in *Diamond v. Diehr*, 450 U.S. 175, 101 S.Ct. 1048, 67 L.Ed.2d 155 (1981)." *SAP America*, 758 F. 3d at 1022.

Petitioner Ex-1004, 0249

Similarly, the present claimed invention apply mathematics to obtain improvements in the use of PPG data in physiological parameter measurement where the output is a heart rate, oxygen saturation in blood, blood loss, or the measurement of atrial fibrillation.

As the Federal Circuit Court Stated In Finjan, Inc. v. Blue Coat Systems, Inc., "Starting at step one [of Alice], [one] must first examine the [application's] "claimed advance" to determine whether the claims are directed to an abstract idea." Finjan, Inc. v. Blue Coat Systems, Inc., opinion 2016-2520 (Fed. Cir. January 10, 2018) (citing *Affinity Labs of Tex., LLC v. DIRECTV, LLC*, 838 F.3d 1253, 1257 (Fed. Cir. 2016)).

The application's claimed advance over the prior art, by outperforming the other MNA detection techniques while avoiding the problems of distortion of the non-corrupted data, is to solve the problems brought about by the effect of motion on the use of PPG signals and to enable the use of PPG for ambulatory monitoring applications.

Where the method of *Research Corporation* helped improve upon prior halftoning processes, the method in McRo improves the display of lip synchronization and the method in *Thales Visionix* improves a tracking system. Claim 1 helps improve upon the use of prior methods of Motion and Noise Artifact (MNA) detection in physiological parameter monitoring while avoiding the problems of distortion of the non-corrupted data.

Applicants respectfully state that the present claims should be found to be patentable subject matter under section 101 as an improvement on the use of PPG signals by solving the problems brought about by the effect of motion on the use of PPG signals and to enabling the use of PPG for ambulatory monitoring applications.

Step two

The Courts have recognized that the two steps of the *Alice/Mayo* test "are easier to separate in recitation than in application" (*see, AG (RNBx) Ameranth v. Genesis Gaming Solutions*, Order Denying Motion for Summary Judgment of Invalidity, Central District CA Case No. SACV 11-00189, January 2, 2015; *BASCOM Global Internet Services., Inc. v. AT&T*

Petitioner Ex-1004, 0250

Mobility LLC, 827 F.3d 1341, 1349 (Fed. Cir. 2016)). Although Applicants do not acquiesce to the assertions of the Examiner to the effect that Applicants' claims are directed to an abstract idea, Applicants present the following arguments in response to the application of step two of the *Alice/Mayo* test to the analysis of Applicants' invention.

The Supreme Court in the *Alice* decision stated that "an invention is not rendered ineligible for patent simply because it involves an abstract concept. … '[A]pplication[s]' of such concepts "'to a new and useful end,'" we have said, remain eligible for patent protection." *Alice*, 134 S. Ct. at 2354 (citations omitted).

As the Federal Circuit stated in *Rapid Litigation Management*, under step two of the *Alice* test, claims that are "directed to" a patent-ineligible concept, yet also "improve[] [sic] an existing technological process," are sufficient to "transform[] the process into an inventive application" of the patent-ineligible concept. *Rapid Litigation Management,* 827 F.3d at 1050 (citing *Alice*, 134 S. Ct. at 2358 (quoting *Mayo*, 132 S. Ct. at 1299) (discussing *Diamond v. Diehr*, 450 U.S. 175 (1981)).

As stated above, the claimed invention improves the use of PPG data in medical diagnosis and enable the use of PPG for ambulatory monitoring applications. The improvement of the existing technological process is sufficient to transform the process into an inventive application.

The Examiner, in the office action, states that " the additional elements or combination of elements in the claims, other than the abstract idea per se, amount to no more than a recitation of generic computer structure to perform generic computer functions (the processors, computer usable media, etc. - see the below art rejections), that serve to generally link the abstract idea to a particular technological environment or field of use." Using the computer to gather and manipulate data is what the Supreme Court, in *Alice,* called "well known, routine and conventional activities. *Alice*, 134 S. Ct., 2347, 2359 (2014) (citing *Mayo,*132 S. Ct. 1289, 182 L. Ed. 2d 321, 337).

Petitioner Ex-1004, 0251

The Federal Circuit's decision this year in *Berkheimer v. HP Inc.*, 881 F.3d 1360 (Fed. Cir. 2018), expressly stated that patent eligible subject matter is a question of law which may contain underlying facts, and that the question whether something is well-understood, routine, and conventional to a skilled artisan at the time of the patent is a factual determination. *Berkheimer v. HP Inc.*, 881 F.3d 1360, 1368 -1369 (Fed. Cir. 2018). Moreover, whether a particular technology is well-understood, routine, and conventional *goes beyond what was simply known in the prior art. Berkheimer,* 881 F.3d at 1369.

In *Berkheimer v. HP Inc.*, the Federal Circuit considered an invention in which the hardware components were conventional (see Fig. 1 in US patent 7,447,713, at issue in that case) and the claims were considered directed to an abstract idea. *Berkheimer*. 881 F.3d at 1367.

In *Berkheimer,* the limitations were directed to purported improvements and the Federal Circuit raised a genuine issue of material fact as to whether the purported improvements were more that well understood, routine and conventional activity previously known in the industry. *Berkheimer,* 881 F.3d at 1369.

Applicants are provided in the specification (and also cited above) data that shows that the claimed invention improve upon prior methods of Motion and Noise Artifact (MNA) detection while avoiding the problems of distortion of the non-corrupted data.

The Examiner has not presented a citation to a court decision, noting the well understood, routine, conventional nature of the claimed invention, or a citation to a publication, such as a book, manual, or review article that describes the state-of-the-art and discusses what is well known and in common use in the field. (See the April 19, 2018 memorandum on Berkheimer v. HP.)

As in *Berkheimer*, there is a genuine issue of material fact as to whether it is routine and conventional to use the claimed invention to detect corrupt segments, due to MNA, in PPG or equivalent data.

Petitioner Ex-1004, 0252

Applicants respectfully state that the Examiner's statements are not supported by substantial evidence.

Applicants respectfully state that the claims recite patentable subject matter.

THE 35 U.S.C. 102 REJECTIONS

Claims 1, 2, 15, 16, 18, 19, 32, 33 and 35 are rejected under 35 U.S.C. 102(a) (1) as being anticipated by US Patent Application Publication 2011/0077484 ("Van Slyke").

Claim 1 has been amended to include the limitations of allowable claim 7 and intervening claims. Claim 2 is canceled. Claim 18 has been amended to include the limitations of allowable claim 24 and intervening claims. Claim 19 is canceled. Claim 35 has been amended to include limitations of allowable claim 24. Claims 15, 16 depend on amended claim 1. Claims 32, 33 depend on amended claim 18.

Applicants respectfully state that claims 1, 15, 16, 18, 32, 33 and 35 as amended are not anticipated by Van Slyke.

THE 35 U.S.C. 103 REJECTIONS

Claims 3, 4, 6, 20, 21, and 23 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke in view of US Patent 5,853,364 ("Baker") and International Application Publication WO 2013/043157 ("Brockway").

Claims 3, 4, 6, 20, 21, and 23 are canceled.

Claims 5 and 22 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke-Baker-Brockway in view of non-patent publication Couceiro, Ricardo, et al. "Detection of motion artifacts in photoplethysmographic signals based on time and period domain analysis." 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2012 ("Couceiro").

Petitioner Ex-1004, 0253

Claims 5 and 22 are canceled.

Claims 9, 12, 26, and 29 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke-Baker-Brockway in view of US Patent Application Publication 2016/0270733 ("Hansson").

Claims 9, 12, 26 and 29 are canceled.

Claims 17 and 34 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke-Baker-Brockway in view of US Patent Application Publication 2008/0287815 ("Chon").

Claim 36 is rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke in view of Couceiro.

Claim 35 has been amended to include limitations of allowable claim 24. Claim 36 depend on claim 35.

As stated in the Office Action, neither Van Slyke nor Couceiro teach or suggest a noise quality index from a time frequency spectrum, the noise quality index being based on a weighted sum of residual noise power, as specified, and a projected difference or a heart rate frequency difference.

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.

Applicants believe the claims are in allowable condition. A notice of allowance for this application is solicited earnestly. If the Examiner has any further questions regarding this amendment, he/she is invited to call Applicants' attorney at the number listed below.

Petitioner Ex-1004, 0254

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. 30210-216.

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: December 11, 2018

By: /Orlando Lopez/
Orlando Lopez
Reg. No. 46,880
Attorney for Patent Application Owner

Petitioner Ex-1004, 0255

APPENDIX

4849-1581-7858.3

Petitioner Ex-1004, 0256

OTHER PAPERBACK TITLES OF INTEREST:

The Elements of Style
William Strunk, Jr. and E. B. White

The Elements of Editing
Arthur Plotnik

Writing That Means Business
Ellen Roddick

The Art of Readable Writing
Rudolf Flesch

THE Elements of Grammar

Margaret D. Shertzer

COLLIER BOOKS
MACMILLAN PUBLISHING COMPANY
NEW YORK
COLLIER MACMILLAN PUBLISHERS
LONDON

Petitioner Ex-1004, 0257

29. Use a comma to set off words, phrases, and clauses that would otherwise be unclear.

Wrong: This ticket is good for dinner or bed and breakfast.
Right: This ticket is good for dinner, or bed and breakfast.
Wrong: When I was about to begin the speech ended.
Right: When I was about to begin, the speech ended.

30. For use of the comma with parentheses, see p. 107.

31. Omit the comma before the ZIP Code number in an address on an envelope; place the number two spaces after the two-letter state abbreviation.

The Semicolon

While the comma is frequently used in place of the semicolon in business letters, newspapers, and magazines, the semicolon has a place in modern writing. The following are the generally accepted rules for the use of the semicolon.

1. Use a semicolon between the clauses of a compound sentence when the conjunction is omitted or when the connection is not close.

The Working Girl, long harassed and patronized, has earned her way to linguistic equality; a sign of the changing times is that it is not possible to say that Heaven protects the Career Woman.

WILLIAM SAFIRE, *On Language*

The statistical evidence is there; it cannot be denied.

I had no flair for politics as an art form; my interest was solely in the content of the candidate's message.

GEORGE BALL

2. Use a semicolon to separate coordinate clauses when they are long or when they contain commas.

The good modern letterwriter does not employ hackneyed expressions, for they make letters sound boring, lacking in individuality; they deprive letters of personal flavor; they clog the message, blur the meaning, confuse the construction.

We are not happy simply being useful; we want to identify with something, and thus we have courses on creative writing, creative advertising, and creative salesmanship.

J. S. BRUNER

3. Use the semicolon in lists of names with titles or addresses and in other lists that would not be clear if separated by commas.

Other speakers on the program were L. R. Alderman, Specialist in Adult Education in the U.S. Bureau of Education; Miss Willie Lawson, Deputy State Superintendent of Public Schools, Little Rock, AR; and Reed Lewis, Director of Foreign Language Information Service, New York City.

Officers elected for the coming year are as follows: president, James Thomas; secretary, Raymond Colt; treasurer, Kenneth Graham.

The survey was made in Hartford, Torrington, and Winsted in Connecticut; and in Springfield, Worcester, and Boston in Massachusetts.

Invitations to the dedication should be sent to Mrs. Burton Allen, 11 Lake Road, Newton Centre, MA; Miss Helen Wollaston, 26 Adelaide Avenue, Barrington, RI; and Dr. Luke Randall, Pleasant Valley, CT.

Horton's experience, according to his letter, has been two years as salesman for Bradford & Crane, Orlando, FL, four years as sales manager for The Norton Company, Kansas City, MO, and five years as buyer for Hall Brothers, Richmond, VA.

Where there would be no confusion, the comma may be used instead of the semicolon.

Regional offices are located in New York, NY, Chicago, IL, and Dallas, TX.

In lists of books with specific references to volume number, chapter number, pages, etc. (often given in

footnotes to speeches, reports, or articles), each complete item should be separated by a semicolon.

Political Conditions in the South in 1868: Dunning, *Reconstruction, Political and Economic* (American Nation Series), pp. 109–123; Hart, *American History Told by Contemporaries*, Vol. IV, pp. 445–456, 497–500; Elson, *History of the United States*, pp. 790–805.

Psalms 23.1–4; 37:3–5; 91:1–10.

4. Use a semicolon to separate groups of words, whether phrases or clauses, dependent on a general term or statement.

He declared that physical exercise has many benefits: it strengthens the muscles of the legs; it increases the flow of blood throughout the body; it improves the appetite; and it helps to prevent osteoporosis.

We hold these truths to be self-evident—that all men are created equal; that they are endowed by their Creator with certain inalienable rights; that among these are life, liberty, and the pursuit of happiness.

THOMAS JEFFERSON

5. Use a semicolon to precede *for example, namely, for instance, viz., to wit, as, i.e.* when they introduce an enumeration of examples not felt to be parenthetical or when they precede a principal statement or a sentence. (*See* pp. 83–84 for use of comma, and p. 92 for use of colon.)

The examinations will include practical demonstrations of professional skills in actual life situations; for example, a secretary in an actual office situation, a teacher in an actual classroom, and a nurse with an actual patient.

Before purchasing a condominium, a buyer should consider a number of aspects; namely, location, construction quality, and financing.

[A stampede of cattle] could not be foretold; anything might start it; for instance, the sudden bark of a coyote, a rumble of a summer storm, lightning, the rearing of a horse,

or the scream of a panther could all set off a disastrous stampede.

HORAN and SANN, *Pictorial History of the Wild West*

6. Use a semicolon to separate clauses joined by such transitional words as *hence, moreover, however, also, therefore, consequently*. Follow these words by commas when they themselves should be emphasized.

The principles are almost universally accepted; hence you should learn them.

The speaker saw no objection to the suggestion; therefore, she accepted it.

7. Use a semicolon to separate lengthy statements following a colon.

Amos Rapoport in *House Form and Culture* supports this view when he carefully lists three categories of architecture: 1. primitive—built with few modifications by all people on a common model; 2. vernacular—divided into preindustrial, which is built by tradesmen on a model that comes from the people (folk art), and post-industrial, built by specialists, from a model for the people (mass-culture art); and 3. high-style—built by specialists (architects) for an elite cultural group.

ROBERT L. VICKERY, JR., *Sharing Architecture*

8. Place a semicolon outside quotation marks. (*See also* p. 103.)

We called him "Lucky"; he preferred "Lawrence."

"Infer" means "conclude"; "imply" means "suggest."

9. Place a semicolon after the parentheses when the parenthetical matter explains something that precedes.

What we are actually discussing here is the Planned Unit Development (PUD as it is called within the development profession); which is a large assemblage of land, usually 100 acres or more, in which single-family houses are mixed with higher density apartments and are clustered around cul-de-sacs.

ROBERT L. VICKERY, JR., *Sharing Architecture*

Petitioner Ex. 1004, 0269

A GRAMMAR BOOK for You and I . . . OOPS, Me!

All the Grammar You Need to Succeed in Life

C. EDWARD GOOD



CAPITAL BOOKS, INC.
Sterling, Virginia

Petitioner Ex. 1004, 0260

34

Semicolon

Top writers do not use the semicolon as much today as they did in the past. As a matter of style, you should try to avoid using too many sentences consisting of two independent clauses joined by a semicolon. The mark does have its uses, however, and when you do join two independent clauses without a conjunction, you must use the semicolon (or a colon).

SEMICOLON AND INDEPENDENT CLAUSES

A semicolon separates two or more independent clauses joined without a coordinating conjunction:

> The Court required police to warn suspects of their constitutional rights; in doing so, it made judicial history.

HOWEVER AND OTHER CONJUNCTIVE ADVERBS

Conjunctive adverbs include *however, therefore, thus, furthermore,* and others.

If you use a conjunctive adverb to join two independent clauses, then use a semicolon, followed by the conjunctive adverb, followed by a comma:

Petitioner Ex. 1004, 0261

The committee had heard these arguments before; therefore, it turned its attention to other matters.

The agency trusted the report; however, the report proved faulty in its scientific method.

One of the most common mistakes in writing involves the use of a comma (not a semicolon) and a conjunctive adverb to join independent clauses:

Wrong: The agency trusted the report, however the report proved faulty in its scientific method.

Right: The agency trusted the report; however, the report proved faulty in its scientific method.

SEMICOLONS SEPARATING ELEMENTS IN A SERIES

We reviewed this rule when we discussed the serial comma rule in chapter 33. It bears repeating, however. When elements in a series are long and complex or involve internal punctuation, they should be separated by semicolons for the sake of clarity:

The company has offices in Greensboro, North Carolina; Atlanta, Georgia; Los Angeles, California; London, England; and Taipei, Taiwan.

The committee reviewed the Jones Report, which was written in 1967; the Jackson Study, which came from the regional office; and the Commissioner's Report, which prompted the initial controversy.

"Since the earliest days philosophers have dreamed of a country where the mind and spirit of man would be free; where there would be no limits to inquiry; where men would be free to explore the unknown and to challenge the most deeply rooted beliefs and principles."[1]

SEMICOLON AND QUOTATION MARKS

The semicolon should be placed *outside* ending quotation marks. When the quoted matter ends with a semicolon, the semicolon in the quotation is dropped:

Petitioner Ex. 1004, 0262

The agency reviewed those petitions that were **"timely"**; it ignored those that were late.

The agency approved those agreements "having no significant impact on **competition"**; it refused to enforce those violating the anti-trust laws.

NOTE

1. Justice Hugo Black, *The Bill of Rights*, 35 N.Y.U. L. Rev. pp. 880–81 (1960).

Petitioner Ex. 1004, 0263

CORRECT ENGLISH USAGE AS IT HAS NEVER BEEN TAUGHT BEFORE: LUCIDLY, MEMORABLY, AND HUMOROUSLY

This inviting book introduces readers anew to the eight parts of speech and common grammatical problems (such as the case of pronouns depicted in the title), the tension between nouns and verbs, the controversy of the active versus passive voice, and the power of a verb-based style.

* * *

"This book will awaken anyone's dormant interest in language—and help people overcome a fear of grammar. With verve and wit, Ed Good rescues grammar from ill-deserved neglect."

—Bryan A. Garner, author, *The Oxford Dictionary of American Usage and Style*, *The Dictionary of Modern American Usage*, and *The Dictionary of Modern Legal Usage*

"Clarity of expression is essential in our business. Ed Good's book—especially in combination with the course he presented at DuPont—provides powerful tools to help our technical writers explain complex scientific concepts in understandable prose."

—Vernon R. Rice, Vice-President, E.I. du Pont de Nemours and Company

"We stress the importance of straightforward, concise, grammatically correct writing. This entertaining book will help us write about complicated subjects in a way our readers can easily comprehend."

—Byron G. Buck II, Senior Intellectual Property Attorney, Caterpillar Inc.

* * *

Praise for Ed Good's Mightier than the Sword: Powerful Writing in the Legal Profession:

"This is a rare feat: a book on writing style and grammar that is easy to follow and fun to read." —*Library Journal*



Ed Good is Counsel & Writer-in-Residence at the intellectual property law firm of Finnegan, Henderson, Farabow, Garrett & Dunner, LLP, in Washington, D.C.

ISBN 978-0-9654362-5-0

Printed in the U.S.A.

1127233

Petitioner Ex. 1004, 0264



The Deluxe Transitive Vampire

The Ultimate Handbook of Grammar for the Innocent, the Eager, and the Doomed



Karen Elizabeth Gordon



Pantheon Books New York

Petitioner Ex. 1004, 0265

Comma Splices and Run-ons

Two independent clauses sometimes try to cohabit a sentence, and, to lend a touch of decorum for their mothers, the neighbors, or a Green Card, slip a sliver of a comma between them – without the necessary link of a coordinating conjunction. And yet, as if to acknowledge that this comma weren't decorum enough, they often invite another word to come between them, as a chaperon – such as *this, another, there,* or *it* – to begin the second clause.

Instead of a comma, a period or semicolon will make sense of this coupling.

Possible solutions:
Insert a semicolon between the two independent clauses – especially when they are closely related; separate them with a period, making two complete sentences; summon a subordinate conjunction to link the thus-created dependent clause with the independent, or main, clause

Splice:
One type of protagonist is looking for himself at the bottom of every river, another type is looking for love.

Sentence:
One type of protagonist is looking for himself at the bottom of every river; another type is looking for love.

Sentence:
While one type of protagonist is looking for himself at the bottom of every river, another type is looking for love.

Splice:
They had a fatal attraction, it was based on *The Myth of Sisyphus* and a love of Harpo Marx.

Petitioner Ex. 1004, 0266

Sentence:
They had a fatal attraction; it was based on *The Myth of Sisyphus* and a love of Harpo Marx.

Splice:
One way to find a sweetheart is to put an ad in the paper, another is to wait and see what the cat drags in.

Sentence:
One way to find a sweetheart is to put an ad in the paper; another is to wait and see what the cat drags in.

Splice:
She wrapped herself up in an enigma, there was no other way to keep warm.

Sentence:
She wrapped herself up in an enigma; there was no other way to keep warm.

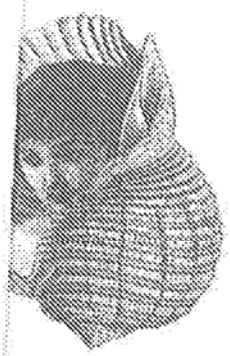
Splice:
Little fauns are stroked on their haunches when they become too raucous, this calms their frisky young nerves.

Sentence:
Little fauns are stroked on their haunches when they become too raucous. This calms their frisky young nerves.

There are instances in which a comma should be used instead of a semicolon. When the clauses are concise and similar in construction or when the sentence has a casual lilt, use a comma between the clauses.

I could hardly believe my senses, he so relieved my fever.
She darkened his door, he lit her fire, they both burned.
Have gun, will travel.





A Procrustean bed?

Petitioner Ex. 1004, 0267

Amendments to the Claims:

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

1. (Currently amended) A computer implemented method for ~~detection of motion and noise artifacts in~~ physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) ~~or equivalent~~ signal, the computer implemented method comprising:

obtaining a time frequency spectrum of a segment of the signal used as the PPG ~~or equivalent~~ signal;

obtaining, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether [[a]]the segment is corrupted by motion and noise artifacts;

wherein obtaining a noise quality index comprises:

determining a dominant frequency in the time frequency spectrum of the segment; and

normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtracting the first, second and third traces of amplitudes from the time frequency spectrum;

obtaining, after subtracting, a total power remaining in the time frequency spectrum, said total power remaining hereinafter referred to as a residual noise power;

determining a difference in frequency between the first trace and the second and third traces, the difference in frequency referred to as a projected difference;

the noise quality index being a weighted sum of the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a

Petitioner Ex-1004, 0268

predetermined percentage of power in an uncorrupted segment;

~~and~~

applying a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if noise/motion artifacts are not present, the segment is included in determination of a physiological parameter.

2. (Canceled)

3. (Canceled)

4. (Canceled)

5. (Canceled)

6. (Canceled)

7. (Canceled)

8. (Currently amended) The computer implemented method of claim [[7]]1 wherein the statistical learning method is a Support Vector Machine (SVM).

9. (Canceled)

10. (Currently amended) The computer implemented method of claim [[9]] 1 further comprising determining a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the PPG or equivalent signal in a time domain, the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference; wherein the noise quality index also comprises the heart rate frequency difference; the noise quality index being a weighted sum of the residual noise power, the projected difference and ~~the~~ heart rate frequency difference, the

Petitioner Ex-1004, 0269

heart rate frequency difference being the difference between the dominant frequency and the heart rate obtained from peak to peak intervals; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

11. (Original) The computer implemented method of claim 10 wherein the statistical learning method is a Support Vector Machine (SVM).

12. (Canceled)

13. (Currently amended) A The computer implemented method of claim 12 physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:

obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;

obtaining, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

wherein obtaining a noise quality index comprises:

determining a dominant frequency in the time frequency spectrum of the segment; and

normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtracting the first, second and third traces of amplitudes from the time frequency spectrum;

obtaining, after subtracting, a total power remaining in the time frequency spectrum, said total power remaining hereinafter referred to as a residual noise power;

Petitioner Ex-1004, 0270

determining a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the PPG or equivalent signal in a time domain, the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference;

~~wherein~~ the noise quality index also comprising the heart rate frequency difference; the noise quality index [[is]] being a weighted sum of the residual noise power and the heart rate frequency difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

~~and~~

applying a statistical learning, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if noise/motion artifacts are not present, the segment is included in determination of a physiological parameter.

14. (Original) The computer implemented method of claim 13 wherein the statistical learning method is a Support Vector Machine (SVM).

15. (Original) The computer implemented method of claim 1 wherein the signal used as the PPG ~~or equivalent~~ signal is preprocessed before obtaining the time frequency spectrum.

16. (Original) The computer implemented method of claim 15 wherein the signal used as the PPG ~~or equivalent~~ signal is preprocessed by filtering with a bandpass filter of predetermined bandwidth.

17. (Original) The computer implemented method of claim 1 wherein the time frequency spectrum is obtained using variable frequency complex demodulation.

Petitioner Ex-1004, 0271

18. (Currently amended) A system for ~~detection of motion and noise artifacts in~~ physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) ~~or equivalent~~ signal, the system comprising:

a processor configured to:

receive the signal used as the PPG ~~or equivalent~~ signal;

obtain a time frequency spectrum of a segment of the signal used as the PPG ~~or equivalent~~ signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether [[a]]the segment is corrupted by motion and noise artifacts; ~~and~~

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum;

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining hereinafter referred to as a residual noise power;

determine a difference in frequency between the first trace and the second and third traces; the difference in frequency referred to as a projected difference;

apply a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if noise/motion artifacts are not present, the segment is included in determination of a

Petitioner Ex-1004, 0272

physiological parameter;

the noise quality index being a weighted sum of the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

19. (Canceled)

20. (Canceled)

21. (Canceled)

22. (Canceled)

23. (Canceled)

24. (Canceled)

25. (Currently amended) The system of claim [[24]]18 wherein the statistical learning method is a Support Vector Machine (SVM).

26. (Canceled)

27. (Currently amended) The system of claim [[26]]18 wherein the processor is further configured to determine a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the signal used as the PPG signal in a time domain; the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference; wherein the noise quality index also comprises the heart rate frequency difference; and, wherein the noise quality index is a weighted sum of the residual noise power, the projected difference and the heart rate frequency difference; ~~weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment~~.

28. (Original) The system of claim 27 wherein the statistical learning method is a Support Vector Machine (SVM).

Petitioner Ex-1004, 0273

29. (Canceled)

30. (Currently amended) A ~~The~~ system ~~of claim 29~~ system for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal, the system comprising:

a processor configured to:

receive the signal used as the PPG signal;

obtain a time frequency spectrum of a segment of the signal used as the PPG signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum;

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining hereinafter referred to as a residual noise power;

determine a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the PPG or equivalent signal in a time domain; the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference;

Petitioner Ex-1004, 0274

~~wherein~~ the noise quality index ~~is~~being a weighted sum of the residual noise power and the heart rate frequency difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

apply a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if noise/motion artifacts are not present, the segment is included in determination of a physiological parameter.

31. (Original) The system of claim 30 wherein the statistical learning method is a Support Vector Machine (SVM).

32. (Currently amended) The system of claim 18 wherein the processor is further configured to preprocess the signal used as the PPG ~~or equivalent~~ signal before obtaining the time frequency spectrum.

33. (Currently amended) The system of claim 32 wherein the processor is configured to preprocess the signal used as the PPG ~~or equivalent~~ signal by filtering with a bandpass filter of predetermined bandwidth.

34. (Original) The system of claim 18 wherein the processor is configured to obtain the time frequency spectrum using variable frequency complex demodulation.

35. (Currently amended) A computer program product comprising:

tangible computer usable media, having computer readable code embodied therein, the computer readable code, when executed by ~~the~~ one or more processors, causes the one or more processors to:

obtain a time frequency spectrum of a segment of a signal used as a PPG ~~or equivalent~~ signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise

Petitioner Ex-1004, 0275

quality index being used to determine whether [[a]]the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum;

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining hereinafter referred to as a residual noise power;

determine a difference in frequency between the first trace and the second and third traces; the difference in frequency referred to as a projected difference;

~~and~~

apply a statistical learning method using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if noise/motion artifacts are not present, the segment is included in determination of a physiological parameter;

wherein the noise quality index is a weighted sum of the residual noise power and the projected differenee; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

Petitioner Ex-1004, 0276

36. (Original) The computer program product of claim 35 wherein the statistical learning method is a Support Vector Machine (SVM).

Petitioner Ex-1004, 0277

DocCode – SCORE

SCORE Placeholder Sheet for IFW Content

Application Number: 15010345 Document Date: 12/11/2018

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via eDAN using the Supplemental Content tab, or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Form Revision Date: August 26, 2013

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon Examiner: SHOSTAK, ANDREY

Application No.: 15/010,345 Confirm. No.: 2095

Filed: 01-29-2016 Art Unit: 3735

For: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

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

SUPPLEMENTAL AMENDMENT AND RESPONSE TO OFFICE ACTION

Sir:

In reply to the Office Action dated September 14, 2018, Applicants submit the following supplemental amendments and remarks.

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

FIG. 1B

FIG. 1D

REPLACEMENT SHEET

1/8

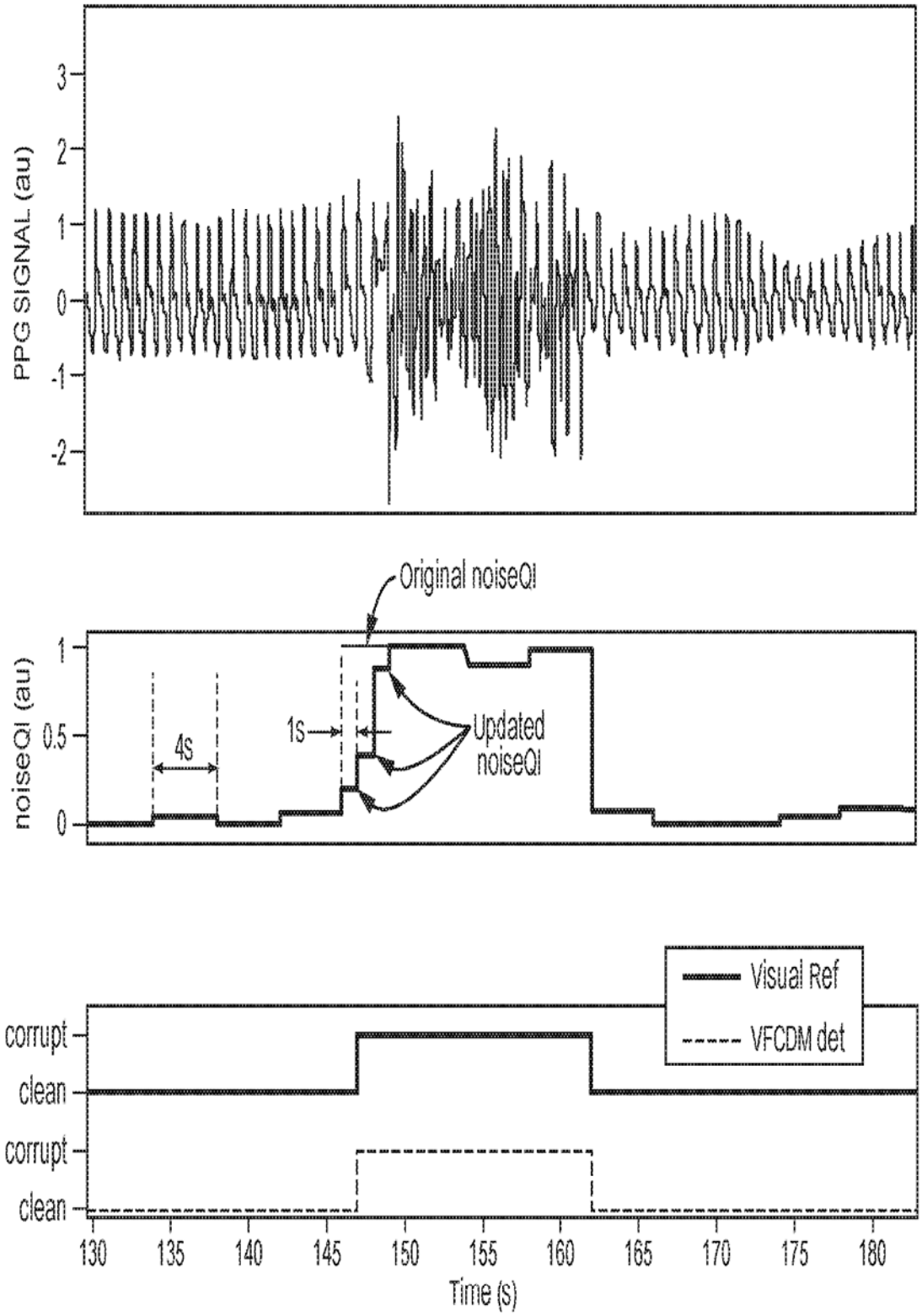

PPG SIGNAL (au)
3
2
1
0
-1
-2
Original noiseQI
noiseQI (au)
1
0.5
0
4s
1s
Updated
noiseQI
Visual Ref
VFCDM det
corrupt
clean
corrupt
clean
130
135
140
145
150
155
160
165
170
175
180
Time (s)

FIG. 3

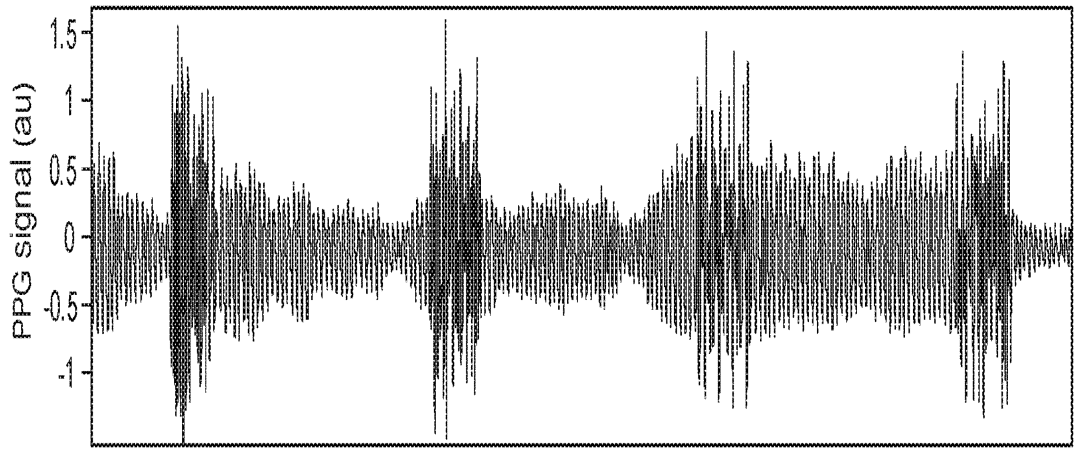


FIG. 4A

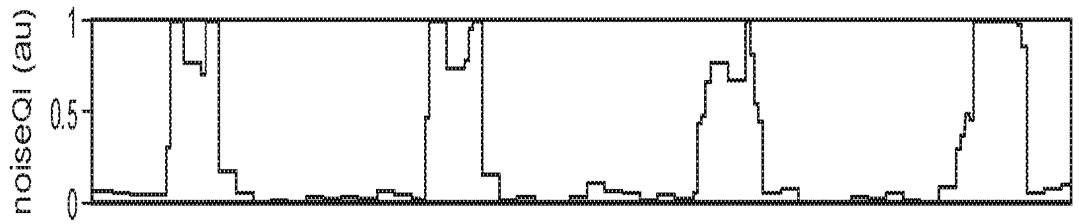


FIG. 4B

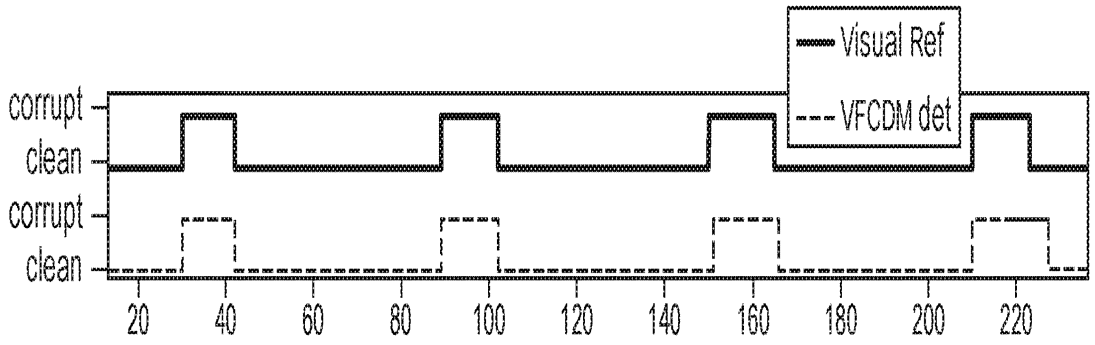


FIG. 4C

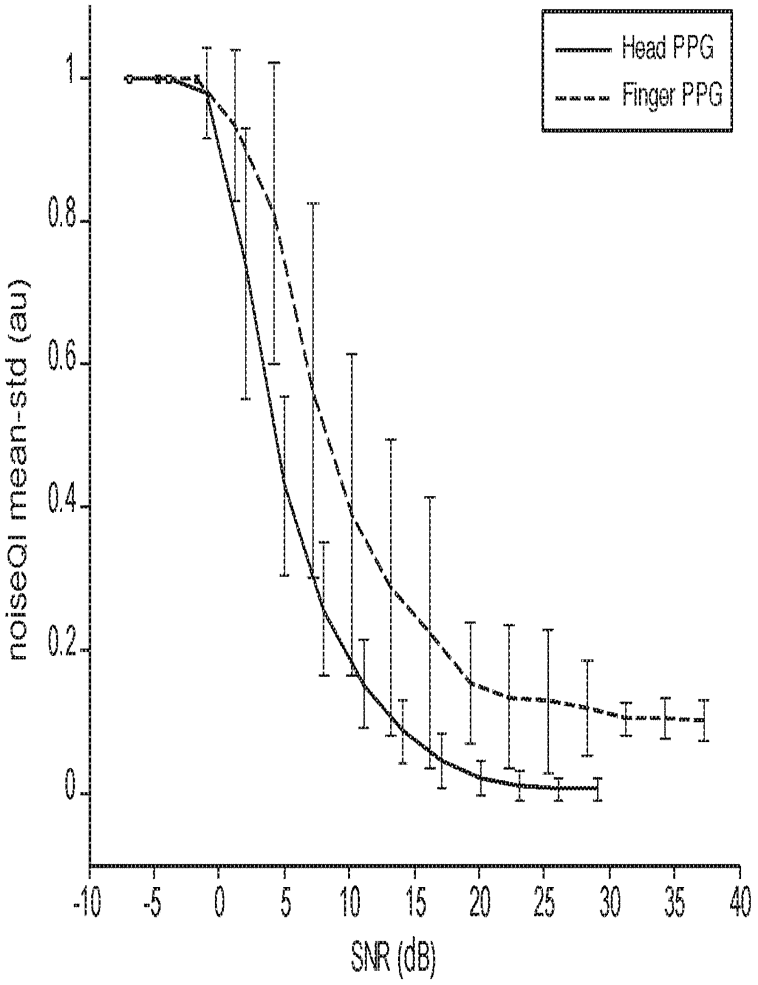

Head PPG
Finger PPG
noiseQI mean-std (au)
SNR (dB)
1
0.8
0.6
0.4
0.2
0
-10
-5
0
5
10
15
20
25
30
35
40

FIG. 5

REPLACEMENT SHEET

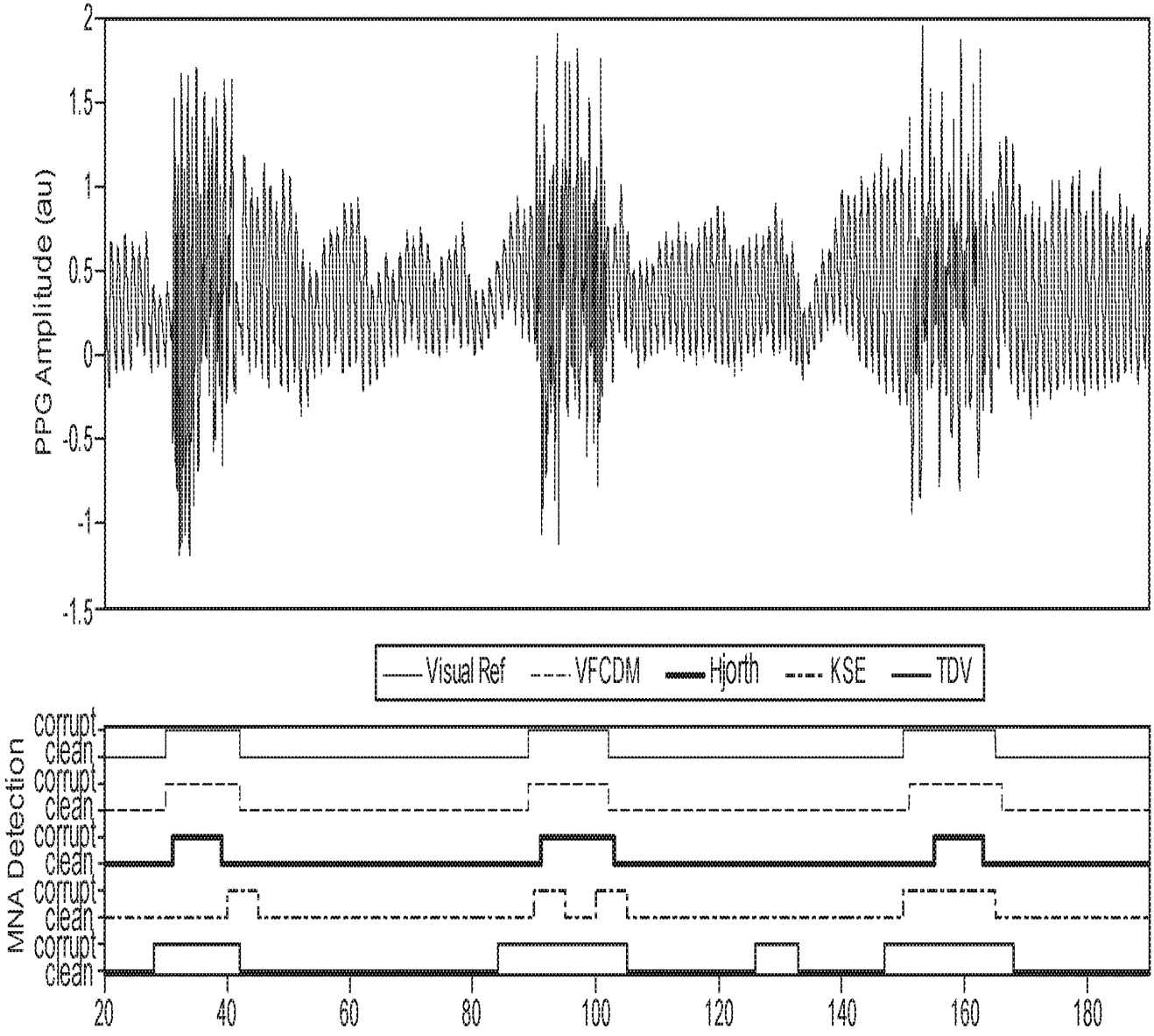


FIG. 6

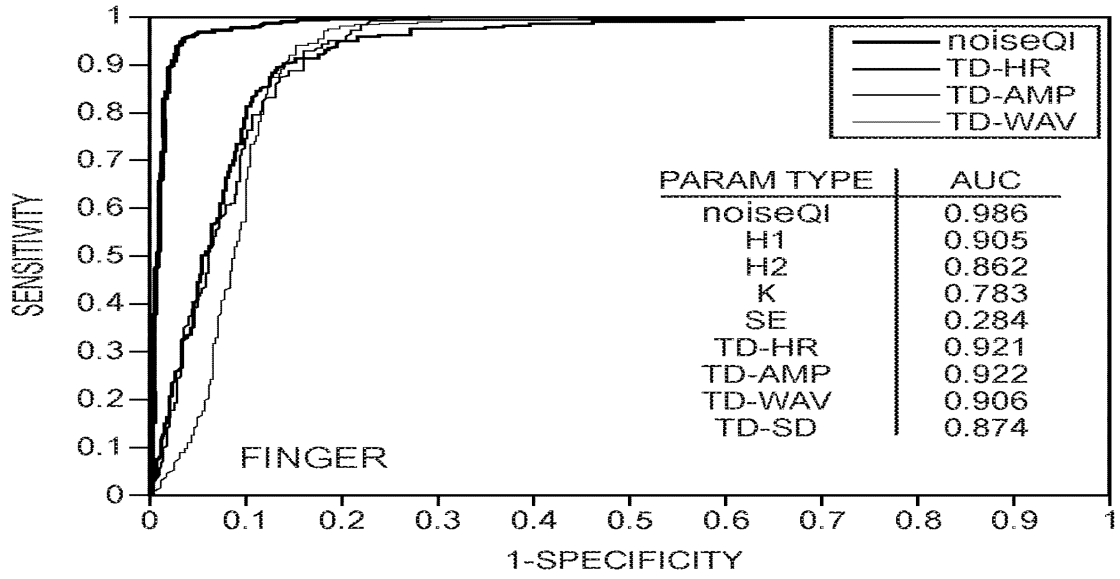

SENSITIVITY
1-SPECIFICITY
FINGER
noiseQI
TD-HR
TD-AMP
TD-WAV
PARAM TYPE | AUC
noiseQI 0.986
H1 0.905
H2 0.862
K 0.783
SE 0.284
TD-HR 0.921
TD-AMP 0.922
TD-WAV 0.906
TD-SD 0.874

FIG. 7A

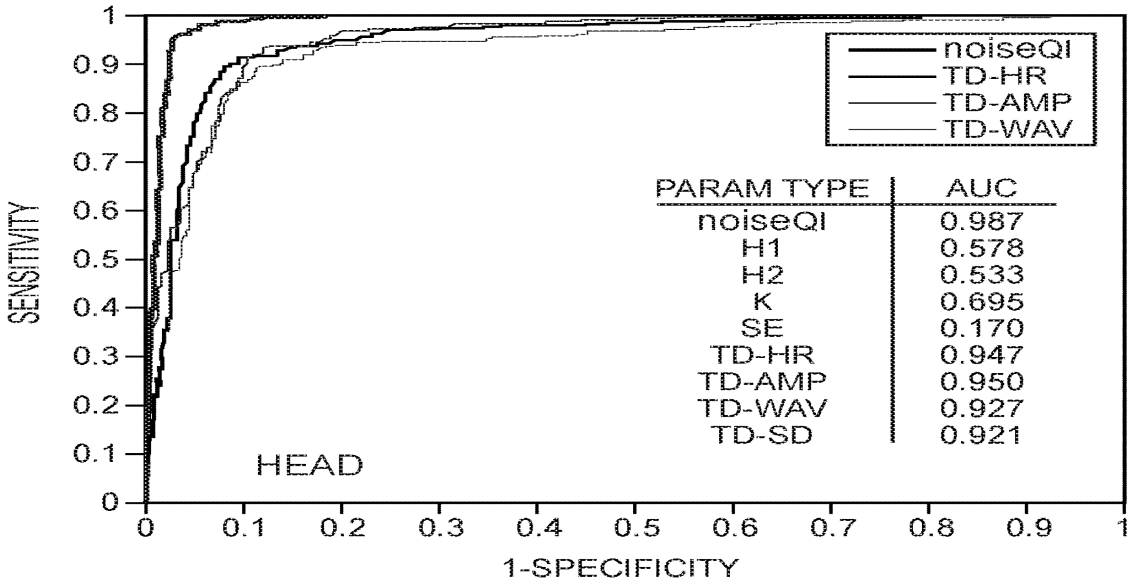

SENSITIVITY
1-SPECIFICITY
HEAD
noiseQI
TD-HR
TD-AMP
TD-WAV
PARAM TYPE | AUC
noiseQI 0.987
H1 0.578
H2 0.533
K 0.695
SE 0.170
TD-HR 0.947
TD-AMP 0.950
TD-WAV 0.927
TD-SD 0.921

FIG. 7B

Electronic Acknowledgement Receipt

EFS ID:	34552114
Application Number:	15010345
International Application Number:	
Confirmation Number:	2095
Title of Invention:	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Orlando Lopez
Filer Authorized By:	
Attorney Docket Number:	30210-216
Receipt Date:	11-DEC-2018
Filing Date:	29-JAN-2016
Time Stamp:	16:04:36
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		3604_001.pdf	68274 14f98211671c96e68eaa5947d92e19dc9bd6e9d4	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Arguments/Remarks Made in an Amendment	2	2
	Supplemental Response or Supplemental Amendment	1	1

Warnings:					
Information:					
2	Drawings-other than black and white line drawings	30210216FIGURES.pdf	139722 2cce63a593db697153e3f673b15b0e7e5510d5c0	no	6
Warnings:					
Information:					
		Total Files Size (in bytes):	207996		

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.

Amendments to the Drawings:

The drawings are objected to because at least Figs. 1B, 1D, 3, 4A-4C, 5, 6, 7A, and 7B.

Replacement sheets are attached. No new matter is added.

CONCLUSION

Applicants believe the claims are in allowable condition. A notice of allowance for this application is solicited earnestly If the Examiner has any further questions regarding this amendment, he/she is invited to call Applicant's attorney at the number listed below.

The Director of Patents and Trademarks is hereby authorized to charge any underpayment of fees, or to credit any overpayments to Deposit Account 03-2410 (Order No. 30210-163).

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: December 11, 2018

By: /Orlando Lopez/
Orlando Lopez, Esq.
Reg. No.: 46,880
Attorney for the Patent Owner

4852-0419-6226.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon Examiner: SHOSTAK, ANDREY

Application No.: 15/010,345 Confirm. No.: 2095

Filed: 01-29-2016 Art Unit: 3735

For: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

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

AMENDMENT AND RESPONSE TO OFFICE ACTION

Sir:

In reply to the Office Action dated September 14, 2018, Applicants submit the following amendments and remarks which place the application in condition for allowance or, in the alternative, in better form for appeal.

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

Amendments to the claims begin on page 4 of this paper.

Remarks begin on page 14 of this paper.

Amendments to the Specification:

Please replace paragraph 28 in the specification with the following paragraph:

"Photoplethysmogram (PPG) or equivalent signal," as used herein, refers to signals obtained from a pulse oximeter or other devices that produce signals that behave like PPG signals obtained from the pulse oximeter. 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, 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. The one or more physiological parameters include heart rate and heart rate variability, respiratory rate, a measure of oxygen saturation, a measure of blood loss, and a measure of atrial fibrillation.

Please replace paragraph 29 in the specification with the following paragraph:

In one or more embodiments, the method of these teachings for detection of motion and noise artifacts in a Photoplethysmogram (PPG) or equivalent signal includes obtaining a time frequency spectrum of a segment of the PPG or equivalent signal, obtaining, from the time frequency spectrum, a noise quality index for the segment and applying a statistical learning method to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts. In one or more embodiments, the method of these teachings for physiological parameter monitoring includes detecting effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements. In detecting effects of motion artifacts in the measurements of the one or more physiological parameters and deciding whether to retain the measurements, if noise/motion artifacts are not present, the segment is included in calculations of quantities of interest.

Please replace paragraph 78 in the specification with the following paragraph:

Petitioner Ex-1004, 0290

The eventual aim of the present algorithm is to detect MNA in real time. The algorithm only takes 33.3ms to compute noiseQI for a 4s PPG window length using ~~Matlab~~ MATLAB® running on a PC with the ~~Intel Xeon~~ INTEL® XEON® processor operating at 3.6GHz. Therefore, it would be straightforward to optimize the algorithm for real time detection of MNA in a PPG signal.

Please replace the abstract with the following:

A pulse oximeter embedded with a ~~novel~~ motion and noise artifact (MNA) detection algorithm based on extraction of time-varying spectral features that are unique to the clean and corrupted components.

Petitioner Ex-1004, 0291

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.
15/010,345	01/29/2016	Ki H. Chon	30210-216	2095

26486 7590 12/14/2018

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

EXAMINER
SHOSTAK, ANDREY

ART UNIT	PAPER NUMBER
3791	

NOTIFICATION DATE	DELIVERY MODE
12/14/2018	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. 15/010,345	Applicant(s) Chon et al.		
	Examiner ANDREY SHOSTAK	Art Unit 3791	AIA (First Inventor to File) Status Yes	Page 1 of 2

All participants (applicant, applicants representative, PTO personnel):

1. ANDREY SHOSTAK (Examiner); Telephonic
2. Orlando Lopez (Attorney); Telephonic
3. Navin Natnithithadha (Primary Examiner); Telephonic

Date of Interview: 06 December 2018

Brief Description of the main topic(s) of discussion: Participants discussed the proposed amendments. It was noted that semicolons were used throughout in place of commas, and that the Examiner would review the attorney's arguments as to the propriety of such usage. It was further noted that portions of the claims appeared to use the term "and" before ultimate elements, and Applicant suggested they would review such usage for potential 35 USC 112(b) issues. The Office also noted that the 35 USC 101 rejections would not be overcome by the proposed amendments, at least in view of SAP America, Inc. v. INVESTPIC, LLC, 898 F. 3d 1161 - Court of Appeals, Federal Circuit 2018. The Office suggested tying the determination by the statistical learning method to the calculated index, and then outputting the result of the determination in a manner that could be appreciated in the real world, to take the abstract idea out of the "black box" (i.e., to make the improvement more than just an improvement in the abstract realm), thereby constituting significantly more than the abstract idea. No specific agreements were reached.

Issues Discussed:

Item(s) under 35 U.S.C. 101:
See above

Formalities:
See above

Attachment(s): Other Attachment
{Proposed Response}

/ANDREY SHOSTAK/ Examiner, Art Unit 3791	/NAVIN NATNITHITHADHA/ Primary Examiner, Art Unit 3791

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

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.

DRAFT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon Examiner: SHOSTAK, ANDREY

Application No.: 15/010,345 Confirm. No.: 2095

Filed: 01-29-2016 Art Unit: 3735

For: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

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

For interview

Sir:

In reply to the Office Action dated September 14, 2018, Applicants submit the following amendments and remarks which place the application in condition for allowance or, in the alternative, in better form for appeal.

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

Amendments to the claims begin on page 3 of this paper.

Remarks begin on page 8 of this paper.

Amendments to the Specification:

Please replace paragraph 78 in the specification with the following paragraph:

The eventual aim of the present algorithm is to detect MNA in real time. The algorithm only takes 33.3ms to compute noiseQI for a 4s PPG window length using ~~Matlab~~ MATLAB® running on a PC with the ~~Intel Xeon~~ INTEL® XEON® processor operating at 3.6GHz. Therefore, it would be straightforward to optimize the algorithm for real time detection of MNA in a PPG signal.

Please replace the abstract with the following:

A pulse oximeter embedded with a ~~novel~~ motion and noise artifact (MNA) detection algorithm based on extraction of time-varying spectral features that are unique to the clean and corrupted components.

Petitioner Ex-1004, 0296

Amendments to the Claims:

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

1. (Currently amended) A computer implemented method for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) ~~or equivalent~~ signal, the computer implemented method comprising:

obtaining a time frequency spectrum of a segment of the signal used as a PPG ~~or equivalent~~ signal;

obtaining, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether [[a]]the segment is corrupted by motion and noise artifacts;

wherein obtaining a noise quality index comprises:

determining a dominant frequency in the time frequency spectrum of the segment; and

normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtracting the first, second and third traces of amplitudes from the time frequency spectrum; and

obtaining, after subtracting, a total power remaining in the time frequency spectrum, said total power remaining hereinafter referred to as a residual noise power;

determining a difference in frequency between the first trace and the second and third traces, the difference in frequency referred to as a projected difference;

the noise quality index being a weighted sum of the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a

Petitioner Ex-1004, 0297

predetermined percentage of power in an uncorrupted segment;

and

applying a statistical learning method to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts.

2. (Canceled)

3. (Canceled)

4. (Canceled)

5. (Canceled)

6. (Canceled)

7. (Canceled)

8. (Currently amended) The computer implemented method of claim [[7]]1 wherein the statistical learning method is a Support Vector Machine (SVM).

9. (Canceled)

10. (Currently amended) The computer implemented method of claim [[9]] 1 further comprising determining a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the PPG or equivalent signal in a time domain, the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference; wherein the noise quality index also comprises the heart rate frequency difference; the noise quality index being a weighted sum of the residual noise power, the projected difference and ~~the~~ heart rate frequency difference, the heart rate frequency difference being the difference between the dominant frequency and the heart rate obtained from peak to peak intervals~~; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment~~.

Petitioner Ex-1004, 0298

11. (Original) The computer implemented method of claim 10 wherein the statistical learning method is a Support Vector Machine (SVM).

12. (Canceled)

13. (Currently amended) A ~~The~~ computer implemented method ~~of claim 12~~ for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal~~,~~ the computer implemented method comprising:

obtaining a time frequency spectrum of a segment of the signal used as a PPG ~~or equivalent~~ signal;

obtaining, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

wherein obtaining a noise quality index comprises:

determining a dominant frequency in the time frequency spectrum of the segment; and

normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtracting the first, second and third traces of amplitudes from the time frequency spectrum; and

obtaining, after subtracting, a total power remaining in the time frequency spectrum, said total power remaining hereinafter referred to as a residual noise power;

determining a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the PPG or equivalent signal in a time domain, the difference between the

Petitioner Ex-1004, 0299

dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference;

wherein the noise quality index also comprises the heart rate frequency difference; the noise quality index [[is]] being a weighted sum of the residual noise power and the heart rate frequency difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

and

applying a statistical learning method to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts.

14. (Original) The computer implemented method of claim 13 wherein the statistical learning method is a Support Vector Machine (SVM).

15. (Original) The computer implemented method of claim 1 wherein the signal used as a PPG ~~or equivalent~~ signal is preprocessed before obtaining the time frequency spectrum.

16. (Original) The computer implemented method of claim 15 wherein the signal used as a PPG ~~or equivalent~~ signal is preprocessed by filtering with a bandpass filter of predetermined bandwidth.

17. (Original) The computer implemented method of claim 1 wherein the time frequency spectrum is obtained using variable frequency complex demodulation.

18. (Currently amended) A system for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) ~~or equivalent~~ signal, the system comprising:

a processor configured to:

receive the signal used as a PPG ~~or equivalent~~ signal;

obtain a time frequency spectrum of a segment of the signal used as a PPG ~~or equivalent~~ signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether [[a]]the segment is corrupted by motion and noise artifacts; ~~and~~

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum; and

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining hereinafter referred to as a residual noise power;

determine a difference in frequency between the first trace and the second and third traces; the difference in frequency referred to as a projected difference;

apply a statistical learning method to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

wherein the noise quality index is a weighted sum of the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

19. (Canceled)

20. (Canceled)

21. (Canceled)

22. (Canceled)

23. (Canceled)

Petitioner Ex-1004, 0301

24. (Canceled)

25. (Currently amended) The system of claim [[24]]18 wherein the statistical learning method is a Support Vector Machine (SVM).

26. (Canceled)

27. (Currently amended) The system of claim [[26]]18 wherein the processor is further configured to determine a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the signal used as a PPG signal in a time domain; the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference; wherein the noise quality index also comprises the heart rate frequency difference; and, wherein the noise quality index is a weighted sum of the residual noise power, the projected difference and the heart rate frequency difference~~; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment~~.

28. (Original) The system of claim 27 wherein the statistical learning method is a Support Vector Machine (SVM).

29. (Canceled)

30. (Currently amended) A ~~The~~ system ~~of claim 29~~ system for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal, the system comprising:

a processor configured to:

receive the signal used as a PPG signal;

obtain a time frequency spectrum of a segment of the signal used as a PPG signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum; and

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining hereinafter referred to as a residual noise power;

determine a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the PPG or equivalent signal in a time domain; the difference between the dominant frequency and the heart rate obtained from peak to peak intervals hereinafter referred to as a heart rate frequency difference;

wherein the noise quality index is a weighted sum of the residual noise power and the heart rate frequency difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

apply a statistical learning method to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts.

31. (Original) The system of claim 30 wherein the statistical learning method is a Support Vector Machine (SVM).

32. (Currently amended) The system of claim 18 wherein the processor is further configured to preprocess the signal used as a PPG ~~or equivalent~~ signal before obtaining the time frequency spectrum.

Petitioner Ex-1004, 0303

33. (Currently amended) The system of claim 32 wherein the processor is configured to preprocess the signal used as a PPG ~~or equivalent~~ signal by filtering with a bandpass filter of predetermined bandwidth.

34. (Original) The system of claim 18 wherein the processor is configured to obtain the time frequency spectrum using variable frequency complex demodulation.

35. (Currently amended) A computer program product comprising:

tangible computer usable media, having computer readable code embodied therein, the computer readable code, when executed by ~~the~~ one or more processors, causes the one or more processors to:

obtain a time frequency spectrum of a segment of a signal used as a PPG ~~or equivalent~~ signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether [[a]]the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum; and

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining hereinafter referred to as a residual noise power;

determine a difference in frequency between the first trace and the second and third

Petitioner Ex-1004, 0304

traces; the difference in frequency referred to as a projected difference;

and

apply a statistical learning method to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

wherein the noise quality index is a weighted sum of the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

36. (Original) The computer program product of claim 35 wherein the statistical learning method is a Support Vector Machine (SVM).

Petitioner Ex-1004, 0305

REMARKS

The Office Action of has been carefully reviewed, and this response addresses the Examiner's concerns. Applicants respectfully request entry of this amendments into the application.

STATUS OF THE CLAIMS

Claims 1-36 are pending in the application.

Claims 1-36 are rejected.

Claims 7, 8, 10, 11, 13, 14, 24, 25, 27, 28, 30, and 31 are allowable over the prior art.

Claims 2-7, 9, 12, 19-24, 26, and 29 are canceled.

Claim 1 has been amended to include the limitations of claims 2-3 and 6-7. Claim 10 has been amended to include the limitations of claim 9. Claim 13 has been amended in order to render it in independent, including the limitations of all the intervening claims. As in claim 18, has been amended to include the limitations of claims, 19, 20, and 23-24. Claim 25 is amended in order to make it dependent on claim 18. Claim 27 is amended in order to include the limitations of claim 26. Claim 30 is amended in order to render it independent and including the limitations of all of the intervening claims. Claims 35 is amended in order to include the limitations included in amended claim 1.

A

Amendments to the Specification:

The Examiner, in the Office Action, states that :

"The disclosure is objected to because of the following informalities: The use of the terms MASIMO, MASIMO RADICAL, INTEL, XEON, and MATLAB, which are trade names or marks used in commerce, has been noted in this application. They should be (1a) in ALL CAPS or (1b) accompanied by the appropriate symbol (™, SM, or ®) wherever they appear, and be (2) accompanied by the generic terminology. See MPEP 608.01(v).

Although the use of trade names and marks used in commerce (i.e., trademarks, service marks, certification marks, and collective marks) are permissible in patent applications, the

proprietary nature of the marks should be respected and every effort made to prevent their use in any manner which might adversely affect their validity as commercial marks."

Applicants respectfully state that a search of the Masimo website shows that Masimo does not mark its name as registered and that a search of the USPTO website shows that the Masimo name is only registered as a typed drawing that Masimo Radical is not trademarked (but RADICAL-7 is). Applicants respectfully state that the trademark SET is registered by Masimo and that, in the Masimo website, is referred to as Masimo SET®, as used in the application.

CLAIM OBJECTIONS

Claim 5 is objected to because of the following informalities: the recitation of "Mahine" is a typographical error and should instead read --Machine--. Appropriate correction is required.

CLAIM REJECTIONS - 35 USC § 112

Claims 1-36 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

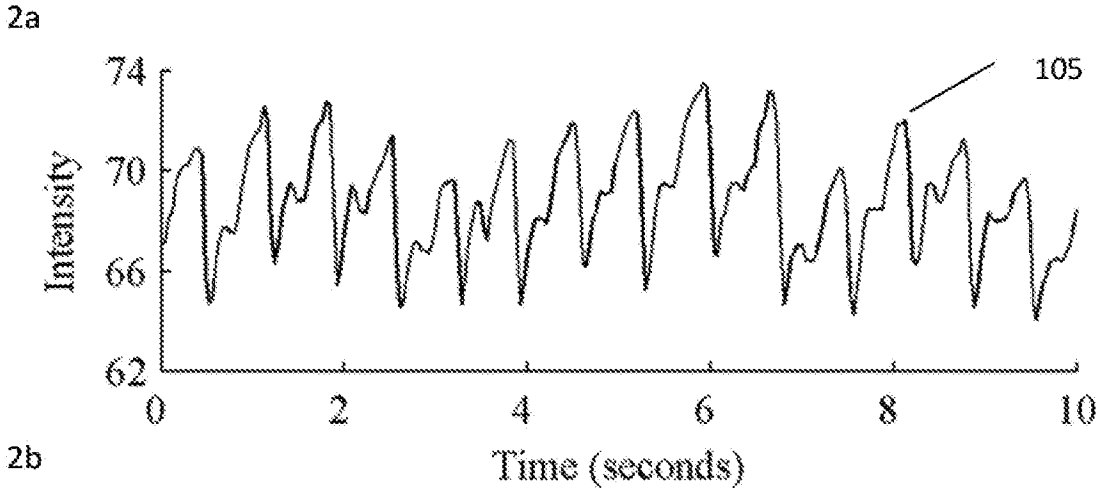
The test for definiteness under 35 U.S.C. § 112, second paragraph, is whether "those skilled in the art would understand what is claimed when the claim is read in light of the specification." *Orthokinetics, Inc. v. Safety Travel Chairs, Inc.*, 806 F.2d 1565, 1576 (Fed. Cir. 1986); MPEP 2173.02.

The examiner, in the office action, states that "**Regarding claims 1, 9, 12, 15, 16, 18, 26, 29, 32, 33, and 35,** they each recite "equivalent signal," which is a relative phrase which renders the claim indefinite. The phrase "equivalent signal" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. Specifically, it is unclear

what kind of signal would be considered an equivalent. ¶ 0028 of the specification defines them as signals which behave like PPG signals, but it is unclear what behavior/signal qualities are intended or encompassed."

Applicants respectfully state that an example of what are equivalent signals is provided in paragraph 81 of the specification, which states "The capability to extract accurate PPG equivalent signals, HR signals, heart rate variability dynamics, the respiratory rates and oxygen saturation information directly from the green, red, and blue band signals from a smart phone is detailed in a recently published paper (see also PCT Publication No. WO2012100175, corresponding to PCT/US2012/022049, PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE, filed on January 20, 2012, and corresponding U.S. Published application 2012190947, PHYSIOLOGICAL PARAMETER MONITORING WITH A MOBILE COMMUNICATION DEVICE, which are incorporated by reference herein in their entirety and for all purposes)."

In paragraph 79 of , U.S. Published application 2012190947, it is stated that "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." Fig. 2a is reproduced below:



The above is a reflective PPG signal. The typical PPG signal is a transmissive PPG signal.

Applicants respectfully state that one skilled in the art, upon being in the specification, would know what is claimed by "equivalent to PPG signals" and would know what "behaving as a PPG signal" entails.
Applicants have amended the claims to state "signals used as PPG signals," which has support in paragraph 81 of the specification.

Regarding claims 3, 6, 9, 12, 20, 23, 26, and 29, the Examiner states that "they each recite "hereinafter referred to as" or "referred to as," which are narrative recitations that fail to particularly point out the invention at least because reference is made to subsequent claims. The terms should be defined first.

Claims 3, 6, 9, 12, 20, 23, 26 and 29 have been canceled. The recitation of hereinafter referred to as now occurs in the midst of the claim so that the reference is not made to a subsequent claim.

Regarding claims 1, 3, 6, 7, 9, 10, 12, 13, 18, 20, 23, 24, 26, 27, 29, 30, and 35, the Examiner states that "the separation and interoperability of elements is unclear because the claims use a

semicolon, instead of e.g. a comma, to further detail particular elements (see e.g. line 5 of claim 1). Is the semicolon intended to introduce a new step, or to further limit a detail of a previous step?"

Applicants respectfully state that the only rule stated in the rules and the MPEP is that a claim is a single sentence. The use of semicolons and sentences is well accepted in grammar (see, for example, Margaret Shertzer, The Elements of Grammar, pp. 88-90, C. Edward Good, A grammar Book for You and I (ops, Me), pp. 378-380, Karen Elizabeth Gordon, The Deluxe Transitive Vampire, p. 160, copies of which are enclosed in the appendix). Examples of the use of semi-colons in claims can be found in the claims of the cited art, US Patent Application Publication 2011/0077484, US Patent 5,853,364 ("Baker") and International Application Publication WO 2013/043157 ("Brockway").
Since; semi-colons have been used in these claims, both for independent clauses and for separating elements in a series (both of which are acceptable, according to grammar), we have a good indication of how the courts will interpret (construe) the claims. The effect of a comma in claim interpretation can be seen in 3Form, Inc. v. Lumicore, Inc. (Fed. Cir. 2015, nonprecedential).

Applicants respectfully state that, since those skilled in the art would understand what is claimed when the claim is read in light of the specification, the claims are definite.

Regarding claims 1, 18, and 35, the Examiner states that "the second recitation of "a segment" makes it unclear whether this is the same as, or different than, the segment contemplated by the first recitation of "a segment.""
Applicants have amended the claims.

Regarding claims 3 and 20, the Examiner states that "the second and third recitations of "a narrow band spectrum" make it unclear whether they are the same as, or different than, the narrow band spectrum contemplated by the first recitation of "a narrow band spectrum.""

Petitioner Ex-1004, 0310

Applicants have amended the claims in order to make them definite.

Regarding claim 19, the Examiner states that "the recitation of "a noise quality index" in line 1 makes it unclear whether this is the same as, or different than, the noise quality index already introduced in claim 18"
Applicants respectfully state that the amended claims are definite.

Regarding claim 35, the Examiner states that "there is insufficient antecedent basis for the recitation of "the one or more processors" in line 3."

Applicants have amended the claim in order to make it definite.

THE 35 U.S.C. 101 REJECTIONS

Claims 1-36 are rejected under 35 U.S.C. 101 because the claimed invention is directed to a judicial exception (i.e., a law of nature, a natural phenomenon, or an abstract idea) without significantly more.

As stated in the specification, extraction of the above mentioned vital signs and other physiological parameters using Pulse Oximeters is predicated on artifact-free PPG data. It is well known that the PPG is highly sensitive to artifacts, particularly those generated while the patient is in motion (Petterson, M. T., V. L. Begnoche, and J. M. Graybeal. The effect of motion on pulse oximetry and its clinical significance. *Anesth. Analg.* 105:S78–84, 2007). This imposes a huge limitation on the usability of the PPG for ambulatory monitoring applications. Motion and noise artifacts (MNAs) distorting PPG recordings can cause erroneous estimation of HR and SpO2 (Sahni, R., A. Gupta, K. Ohira-Kist, and T. Rosen. Motion resistant pulse oximetry in neonates. *Arch. Dis. Child. Fetal Neonatal Ed.* 88:F505–F508, 2003).

Although there are techniques which have been proposed to alleviate the effects of MNA, solutions to this problem still remain unsatisfactory in practice. Several algorithm-based MNA reduction methods have been proposed, such as time and frequency domain filtering, power

Petitioner Ex-1004, 0311

spectrum analysis, and blind source separation techniques. These techniques reconstruct noise contaminated PPG such that a noise-reduced signal is obtained. However, the reconstructed signal typically contains incomplete dynamic features of the uncorrupted PPG signal and some algorithms are solely designed to capture only the HR and SpO2 information instead of the signal's morphology and its amplitudes, which are needed for other physiological derivations. Moreover, these reconstruction algorithms operate even on clean PPG portions where MNA reduction is not needed. This introduces unnecessary computation burden and distorts the signal integrity of the clean portion of the data. Hence, an accurate MNA detection algorithm, which identifies clean PPG recordings from corrupted portions, is essential for the subsequent MNA reduction algorithm so that it does not distort the non-corrupted data segments (Krishnan, R., B. Natarajan, and S. Warren. Two-Stage Approach for Detection and Reduction of Motion Artifacts in Photoplethysmographic Data. *IEEE Trans. Biomed. Eng*. 57:1867– 1876, 2010)..

The method and system of these teachings solve the above stated problems with the present techniques. The present techniques was compared with three other recently published MNA detection algorithms: 1) Hjorth features (Hjorth), 2) time-domain variability SVM (TDV-SVM) approach, and 3) Kurtosis-Shannon Entropy (KSE) features. Performance results of each method are presented in Table II, reproduced below , and show that the present invention outperforms the other MNA detection techniques while avoiding the problems of distortion of the non-corrupted data.

TABLE II. MEAN ± STD. DEVIATION OF PERFORMANCE METRICS OF THE PRESENT VFCDM, OTHER METHODS

		VFCDM	Hjorth		TDV		KSE	
Lab. Head	Acc	96.9 ± 1.4	72.5 ± 10.7	*	93.4 ± 3.5	*	83.1 ± 7.3	*
	Sen	96.3 ± 2.4	47.2 ± 28.8	*	88.8 ± 7.9	*	56.6 ± 17.9	*
	Spe	97.7 ± 2.0	84.4 ± 4.6	*	96.7 ± 3.0		91.5 ± 1.1	*
Umass. Head	Acc	95.5 ± 2.2	69.5 ± 21.8	*	89.8 ± 1.4	*	85.1 ± 8.3	*
	Sen	91.1 ± 3.5	53.8 ± 26.1	*	84.6 ± 2.9	*	68.7 ± 17.7	*
	Spe	96.3 ± 1.4	84.5 ± 8.8	*	94.3 ± 4.0		86.4 ± 7.8	*
Lab. Finger	Acc	97.7 ± 1.4	91.1 ± 6.9	*	94.4 ± 3.3	*	58.5 ± 20.7	*
	Sen	96.3 ± 2.6	83.5 ± 21.0	*	94.7 ± 3.4		34.6 ± 12.2	*
	Spe	98.2 ± 1.4	96.2 ± 3.0		94.7 ± 3.0	*	86.3 ± 15.7	*
Umass. Finger	Acc	95.5 ± 2.4	71.0 ± 19.0	*	89.6 ± 2.3	*	88.3 ± 2.7	*
	Sen	89.2 ± 2.0	41.1 ± 27.6	*	85.2 ± 3.8	*	71.5 ± 8.8	*
	Spe	97.2 ± 2.1	88.4 ± 7.5	*	95.1 ± 0.8		93.6 ± 1.5	*

(*) indicate statistical significance ($p<0.01$) between the present method versus the others

The present invention solves the problems brought about by the effect of motion on the use of PPG signals and does not distortion of the non-corrupted data. The present invention enables the use of PPG for ambulatory monitoring applications.

Section 101 permits the patenting of "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof." 35 U.S.C. § 101. The Supreme Court has interpreted Section 101 to contain "an important implicit exception: Laws of nature, natural phenomena, and abstract ideas are not patentable." *Alice Corp. v. CLS Bank Int'l*, 134 S. Ct. 2347, 2354 (2014) (quoting *Ass'n for Molecular Pathology v. Myriad Genetics*, Inc., 133 S. Ct. 2107, 2116 (2013)).
In *Mayo* and in *Alice*, the Supreme Court set forth a two-step analytical framework to identify patents that, in essence, claim nothing more than abstract ideas. The court must first "determine whether the claims at issue are directed to a patent-ineligible concept."

Petitioner Ex-1004, 0313

Alice, 134 S.Ct. at 2355. If it is determined that the claims are directed to a patent ineligible concept, the analysis proceeds to step two where one must "consider the elements of each claim both individually and 'as an ordered combination' to determine whether the additional elements 'transform the nature of the claim' into a patent-eligible application." *Id.*(quoting *Mayo*, 132 S. Ct. at 1298, 1297).

Step one

Starting with step one, as stated in *Alice* and as the Federal Circuit has stated in *Enfish*, *Rapid Litigation* and *McRo*, the inquiry should be whether the claims are directed a judicial exception. The directed to inquiry is based on whether the character of the claim as a whole is directed to a judicial exception (focus of the claimed advance over the prior art). *Enfish, LLC v. Microsoft Corp,* 822 F.3d 1327 (Fed. Cir. 2016); *Rapid Litigation Management v. CellzDirect*, 827 F.3d 1042, 1048 (Fed. Cir. 2016); *Mcro, Inc. v. Bandai Namco Games America,* 837 F.3d 1299 (Fed. Cir. 2016). The inquiry under step one looks to whether the claims focus on a specific means or method that improves the relevant technology or are instead directed to a result or effect that itself is the abstract idea and merely invoke generic processes and machinery. *Enfish,* 822 F.3d at 1336; *Rapid Litig. Mgmt.,* 827 F.3d at 1048; as cited in *McRo*, 837 F.3d 1299 (Fed. Cir. 2016).

The claimed invention is directed to solving the problems brought about by the effect of motion on the use of PPG signals and does not distort the non-corrupted data and to enabling the use of PPG for ambulatory monitoring applications. The Applicants' claimed invention does not attempt to patent a mathematical formula.

Although the Supreme Court has not established a definitive rule to determine what constitutes an "abstract idea," both the Federal Circuit and the Supreme Court have found it sufficient to compare claims at issue to those claims already found to be directed to an abstract idea in previous cases. *Enfish,* 822 F.3d at 1334 (citing *Alice*, 134 S.Ct. at 2357).

The Examiner, in the Office Action, states that "This idea is similar to the basic concept of manipulating information from source devices using mathematical relationships (e.g. creating device profiles based on processed information, using known mathematical techniques), such as

Petitioner Ex-1004, 0314

in Digitech Image Techs., LLC v Electronics for Imaging, Inc., 758 F.3d 1244, 111 U.S.P.Q.2d 1717 (Fed. Cir. 2014), which has been found by the courts to be an abstract idea."

In *Digitech,* "Claim 10 describes the process for generating the device profile:

> 10. A method of generating a device profile that describes properties of a device in a digital image reproduction system for capturing, transforming or rendering an image, said method comprising:
>
> generating first data for describing a device dependent transformation of color information content of the image to a device independent color space through use of measured chromatic stimuli and device response characteristic functions;
>
> generating second data for describing a device dependent transformation of spatial information content of the image in said device independent color space through use of spatial stimuli and device response characteristic functions; and
>
> combining said first and second data into the device profile."

Digitech, 758 F.3d at 1350-1351. The Court had found that the device profile "as claimed, is a collection of intangible color and spatial information" and held "that the device profile claims of the '415 patent do not encompass eligible subject matter as required by section 101 and are therefore not patent eligible." *Digitech*, 758 F.3d at 1350. The Court states that "The above claim recites a process of taking two data sets and combining them into a single data set, the device profile. The two data sets are generated by taking existing information--*i.e.*, measured chromatic stimuli, spatial stimuli, and device response characteristic functions--and organizing this information into a new form. The above claim thus recites an ineligible abstract process of gathering and combining data that does not require input from a physical device. As discussed above, the two data sets and the resulting device profile are ineligible subject matter."

In contrast, the present claim starts with a Photoplethysmogram (PPG) or equivalent signal and is directed to determining whether segments of the signal are corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts. The corrupted segments can then be removed. The present invention solves the problems brought about by the effect of motion on the use of PPG signals and does not distortion of the non-corrupted data. The present invention enables the use of PPG for ambulatory monitoring applications.

Petitioner Ex-1004, 0315

Since the present claim starts with a Photoplethysmogram (PPG) or equivalent signal and is directed to removing the limitations on the use of PPG for ambulatory monitoring applications and the erroneous estimation of HR and SpO2 caused by corrupted data. The present claims have definite applications and provides improvements in the use of PPG data.

Applicants respectfully state that the present claims are more similar to the claims in *Research Corporation Technologies, Inc. v. Microsoft Corp.,* 627 F.3d 859 (Fed. Cir. 2010). In *Research Corporation Technologies,* the claims recited a mathematical operation of utilizing a blue noise mask for halftoning of gray scale images. For example, claim 1 of the '310 patent recites:

"A method for the halftoning of gray scale images by utilizing a pixel-by-pixel comparison of the image against a blue noise mask in which the blue noise mask is comprised of a random non-deterministic, non-white noise single valued function which is designed to produce visually pleasing dot profiles when thresholded at any level of said gray scale images." *Research Corporation*, 627 F.3d at 865.

In finding the claims to be patent eligible, the Court states that "These inventions address "a need in the art for a method of and apparatus for the halftone rendering of gray scale images in which a digital data processor is utilized in a simple and precise manner to accomplish the halftone rendering."" The Court also states that "inventions with specific applications or improvements to technologies in the marketplace are not likely to be so abstract that they override the statutory language and framework of the Patent Act."" *Research Corporation*, 627 F.3d at 868-869.

Similarly, the present claimed invention has specific applications and improvements in the use of PPG data.

As the Federal Circuit Court Stated In Finjan, Inc. v. Blue Coat Systems, Inc., "Starting at step one [of Alice], [one] must first examine the [application's] "claimed advance" to determine whether the claims are directed to an abstract idea." Finjan, Inc. v. Blue Coat Systems, Inc., opinion 2016-2520 (Fed. Cir. January 10, 2018) (citing *Affinity Labs of Tex., LLC v. DIRECTV, LLC*, 838 F.3d 1253, 1257 (Fed. Cir. 2016)).

The application's claimed advance over the prior art, by outperforms the other MNA detection techniques while avoiding the problems of distortion of the non-corrupted data, is to solve the problems brought about by the effect of motion on the use of PPG signals and to enable the use of PPG for ambulatory monitoring applications.

Where the method of *Research Corporation* helped improve upon prior halftoning processes, Claim 1 helps improve upon prior methods of Motion and Noise Artifact (MNA) detection while avoiding the problems of distortion of the non-corrupted data.

Applicants respectfully state that the present claims should be found to be patentable subject matter under section 101 as an improvement on the use of PPG signals by solving the problems brought about by the effect of motion on the use of PPG signals and to enabling the use of PPG for ambulatory monitoring applications.

Step two

The Courts have recognized that the two steps of the *Alice/Mayo* test "are easier to separate in recitation than in application" (*see*, *AG (RNBx) Ameranth v. Genesis Gaming Solutions*, Order Denying Motion for Summary Judgment of Invalidity, Central District CA Case No. SACV 11-00189, January 2, 2015; *BASCOM Global Internet Services., Inc. v. AT&T Mobility LLC*, 827 F.3d 1341, 1349 (Fed. Cir. 2016)). Although Applicants do not acquiesce to the assertions of the Examiner to the effect that Applicants' claims are directed to an abstract idea, Applicants present the following arguments in response to the application of step two of the *Alice/Mayo* test to the analysis of Applicants' invention.

The Supreme Court in the *Alice* decision stated that "an invention is not rendered ineligible for patent simply because it involves an abstract concept. … '[A]pplication[s]' of such concepts "'to a new and useful end,'" we have said, remain eligible for patent protection." *Alice*, 134 S. Ct. at 2354 (citations omitted).

As the Federal Circuit stated in *Rapid Litigation Management*, under step two of the *Alice* test, claims that are "directed to" a patent-ineligible concept, yet also "improve[] [sic] an existing technological process," are sufficient to "transform[] the process into an inventive

application" of the patent-ineligible concept. *Rapid Litigation Management,* 827 F.3d at 1050 (citing *Alice*, 134 S. Ct. at 2358 (quoting *Mayo*, 132 S. Ct. at 1299) (discussing *Diamond v. Diehr*, 450 U.S. 175 (1981)).

As stated above, the claimed invention improves the use of PPG data in medical diagnosis and enable the use of PPG for ambulatory monitoring applications. The improvement of the existing technological process is sufficient to transform the process into an inventive application.

The Examiner, in the office action, states that " the additional elements or combination of elements in the claims, other than the abstract idea per se, amount to no more than a recitation of generic computer structure to perform generic computer functions (the processors, computer usable media, etc. - see the below art rejections), that serve to generally link the abstract idea to a particular technological environment or field of use." Using the computer to gather and manipulate data is what the Supreme Court, in *Alice,* called "well known, routine and conventional activities. *Alice*, 134 S. Ct., 2347, 2359 (2014) (citing *Mayo,* 132 S. Ct. 1289, 182 L. Ed. 2d 321, 337).

The Federal Circuit's decision this year in *Berkheimer v. HP Inc.*, 881 F.3d 1360 (Fed. Cir. 2018), expressly stated that patent eligible subject matter is a question of law which may contain underlying facts, and that the question whether something is well-understood, routine, and conventional to a skilled artisan at the time of the patent is a factual determination. *Berkheimer v. HP Inc.*, 881 F.3d 1360, 1368 -1369 (Fed. Cir. 2018). Moreover, whether a particular technology is well-understood, routine, and conventional *goes beyond what was simply known in the prior art. Berkheimer,* 881 F.3d at 1369.

In *Berkheimer v. HP Inc.*, the Federal Circuit considered an invention in which the hardware components were conventional (see Fig. 1 in US patent 7,447,713, at issue in that case) and the claims were considered directed to an abstract idea. *Berkheimer*. 881 F.3d at 1367.

Petitioner Ex-1004, 0318

In *Berkheimer,* the limitations were directed to purported improvements and the Federal Circuit raised a genuine issue of material fact as to whether the purported improvements were more that well understood, routine and conventional activity previously known in the industry. *Berkheimer,* 881 F.3d at 1369.

Applicants are provided in the specification (and also cited above) data that shows that the claimed invention improve upon prior methods of Motion and Noise Artifact (MNA) detection while avoiding the problems of distortion of the non-corrupted data.

The Examiner has not presented a citation to a court decision, noting the well understood, routine, conventional nature of the claimed invention, or a citation to a publication, such as a book, manual, or review article that describes the state-of-the-art and discusses what is well known and in common use in the field. (See the April 19, 2018 memorandum on Berkheimer v. HP.)

As in *Berkheimer*, there is a genuine issue of material fact as to whether it is routine and conventional to use the claimed invention to detect corrupt segments, due to MNA, in PPG or equivalent data.

Applicants respectfully state that the Examiner's statements are not supported by substantial evidence.

Applicants respectfully state that the claims recite patentable subject matter.

THE 35 U.S.C. 102 REJECTIONS

Claims 1, 2, 15, 16, 18, 19, 32, 33 and 35 are rejected under 35 U.S.C. 102(a) (1) as being anticipated by US Patent Application Publication 2011/0077484 ("Van Slyke").

Claim 1 has been amended to include the limitations of allowable claim 7 and intervening claims. Claim 2 is canceled. Claim 18 has been amended to include the limitations of allowable

Petitioner Ex-1004, 0319

claim 24 and intervening claims. Claim 19 is canceled. Claim 35 has been amended to include limitations of allowable claim 24. Claims 15, 16 depend on amended claim 1. Claims 32, 33 depend on amended claim 18.

Applicants respectfully state that claims 1, 15, 16, 18, 32, 33 and 35 as amended are not anticipated by Van Slyke.

THE 35 U.S.C. 103 REJECTIONS

Claims 3, 4, 6, 20, 21, and 23 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke in view of US Patent 5,853,364 ("Baker") and International Application Publication WO 2013/043157 ("Brockway").

Claims 3, 4, 6, 20, 21, and 23 are canceled.

Claims 5 and 22 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke-Baker-Brockway in view of non-patent publication Couceiro, Ricardo, et al. "Detection of motion artifacts in photoplethysmographic signals based on time and period domain analysis." 2012 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE, 2012 ("Couceiro").

Claims 5 and 22 are canceled.

Claims 9, 12, 26, and 29 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke-Baker-Brockway in view of US Patent Application Publication 2016/0270733 ("Hansson").

Claims 9, 12, 26 and 29 are canceled.

Claims 17 and 34 are rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke-Baker-Brockway in view of US Patent Application Publication 2008/0287815 ("Chon").

Claim 36 is rejected under 35 U.S.C. 103 as being unpatentable over Van Slyke in view of Couceiro.

Petitioner Ex-1004, 0320

Claim 35 has been amended to include limitations of allowable claim 24. Claim 36 depend on claim 35.

As stated in the Office Action, neither Van Slyke nor Couceiro teach or suggest a noise quality index from a time frequency spectrum, the noise quality index being based on a weighted sum of residual noise power, as specified, and a projected difference or a heart rate frequency difference.

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.

Applicants believe the claims are in allowable condition. A notice of allowance for this application is solicited earnestly. If the Examiner has any further questions regarding this amendment, he/she is invited to call Applicants' attorney at the number listed below.

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. 30210-216.

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: DRAFT

By: _____//_____
Orlando Lopez
Reg. No. 46,880
Attorney for Patent Application Owner

Petitioner Ex-1004, 0321

4828-6578-0354.1

Petitioner Ex-1004, 0322

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

26486 7590 02/14/2019

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

EXAMINER
SHOSTAK, ANDREY

ART UNIT	PAPER NUMBER
3791	

DATE MAILED: 02/14/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/010,345	01/29/2016	Ki H. Chon	30210-216	2095

TITLE OF INVENTION: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	05/14/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

Petitioner Ex-1004, 0323

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

26486 7590 02/14/2019
BURNS & LEVINSON, LLP
125 SUMMER STREET
BOSTON, MA 02110

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/010,345	01/29/2016	Ki H. Chon	30210-216	2095

TITLE OF INVENTION: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	05/14/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
SHOSTAK, ANDREY	3791	600-500000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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.
15/010,345	01/29/2016	Ki H. Chon	30210-216	2095

26486 7590 02/14/2019

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

EXAMINER	
SHOSTAK, ANDREY	
ART UNIT	PAPER NUMBER
3791	

DATE MAILED: 02/14/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Petitioner Ex-1004, 0325

Notice Requiring Inventor's Oath or Declaration	Application No. 15/010,345	Applicant(s) Ki H. Chon	
	Examiner SHOSTAK, ANDREY	Art Unit 3791	

This notice is an attachment to the Notice of Allowability (PTOL-37), or the Notice of Allowability For A Design Application (PTOL-37D).

An inventor's oath or declaration in compliance with 37 CFR 1.63 or 1.64 executed by or with respect to each inventor has not yet been submitted.

An oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each inventor (for any inventor for which a compliant oath, declaration, or substitute statement has not yet been submitted) MUST be filed no later than the date on which the issue fee is paid. See 35 U.S.C. 115(f). Failure to timely comply will result in ABANDONMENT of this application.

A properly executed inventor's oath to declaration has not been received for the following inventor(s):

If applicant previously filed one or more oaths, declarations, or substitute statements, applicant may have received an informational notice regarding deficiencies therein.

The following deficiencies are noted:

INFORMAL ACTION PROBLEMS

- A properly executed inventor's oath or declaration has not been received for the following inventor(s): **Ki H. Chon**, **Jowoon Chong**, **Duy Dao**, and **Hamed Salehizadeh**.
  Applicant may submit the inventor's oath or declaration at any time before the Notice of Allowance and Fee(s) Due, PTOL-85, is mailed.

Questions relating to this Notice should be directed to the Application Assistance Unit at 571-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 30 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
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).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
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.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
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.

Notice of Allowability	Application No. 15/010,345	Applicant(s) Chon et al.	
	Examiner ANDREY SHOSTAK	Art Unit 3791	AIA Status Yes

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

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to the amedment filed 12/11/2018.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ 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.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), 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.**

4. ☐ 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)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☑ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☑ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/ANDREY SHOSTAK/ Examiner, Art Unit 3791	/NAVIN NATNITHITHADHA/ Primary Examiner, Art Unit 3791

Continuation of 3. The allowed claim(s) is/are: 1,8,10-11,13-18,25,27-28 and 30-36

DETAILED ACTION

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in an interview with Orlando Lopez (Reg. # 46,880) on 01/16/2019.

The application has been amended as follows:

In the specification:

[0043] has been replaced with the following paragraph:

[0043] In laboratory-controlled head and finger movement data, motion artifacts were induced by head and finger movements for specific time intervals in both horizontal and vertical directions. For head movement data, 11 healthy volunteers were asked to wear the PO on the forehead along with a reference ~~Masimo~~ MASIMO Radical (~~Masimo~~ MASIMO SET®) finger type transmittance pulse oximeter. After baseline recording for 5 minutes without any movement, subjects were instructed to introduce motion artifacts for specific time intervals varying from 10 to 50% within a 1 minute segment. For example, if a subject was instructed to perform left-right random movements for 6 seconds, 1 min segment of data would contain 10% noise. The finger laboratory movement data were recorded in a similar setup as the head data using a custom-made PPG finger sensor.

[0044] has been replaced with the following paragraph:

[0044] The patient PPG data were recorded from 10 subjects admitted to emergence rooms. Similar to the laboratory-controlled dataset, each patient was fitted with custom-made sensors (both forehead and finger) and the ~~Masimo~~ MASIMO POs on the forehead and fingers, respectively. The patients were admitted due to pain related symptoms and were not restrained from movements. Therefore, they were expected to generate different MNA characteristics in the recorded PPG.

In the claims:

1. (Currently amended) A computer implemented method for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:

obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;

obtaining, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

wherein obtaining a noise quality index comprises:

determining a dominant frequency in the time frequency spectrum of the segment; [[and]]

normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtracting the first, second and third traces of amplitudes from the time frequency spectrum;

obtaining, after subtracting, a total power remaining in the time frequency spectrum, said total power remaining ~~hereinafter~~ referred to as a residual noise power;

determining a difference in frequency between the first trace and the second and third traces, the difference in frequency referred to as a projected difference;

the noise quality index being a weighted sum of factors including the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

applying a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if ~~noise/motion~~ motion and noise artifacts are not present, ~~the segment is included~~ including the segment in determination of a physiological parameter.

10. (Currently amended) The computer implemented method of claim 1 further comprising determining a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the signal used as the PPG ~~or equivalent~~ signal in a time domain, the difference between the dominant frequency and the heart rate obtained from peak to peak intervals ~~hereinafter~~ referred to as a heart rate frequency difference; wherein

the noise quality index also comprises the heart rate frequency difference; the noise quality index being a weighted sum of factors including the residual noise power, the projected difference and the heart rate frequency difference~~, the heart rate frequency difference being the difference between the dominant frequency and the heart rate obtained from peak to peak intervals ment~~.

13. (Currently amended) A computer implemented method for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:

obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;

obtaining, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

wherein obtaining a noise quality index comprises:

determining a dominant frequency in the time frequency spectrum of the segment; [[and]]

normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtracting the first, second and third traces of amplitudes from the time frequency spectrum;

obtaining, after subtracting, a total power remaining in the time frequency spectrum, said total power remaining ~~hereinafter~~ referred to as a residual noise power;

determining a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the signal used as the PPG ~~or equivalent~~ signal in a time domain, the difference between the dominant frequency and the heart rate obtained from peak to peak intervals ~~hereinafter~~ referred to as a heart rate frequency difference;

the noise quality index also comprising the heart rate frequency difference; the noise quality index being a weighted sum of factors including the residual noise power and the heart rate frequency difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

applying a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if ~~noise/motion~~ motion and noise artifacts are not present, ~~the segment is included~~ including the segment in determination of a physiological parameter.

18. (Currently amended) A system for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the system comprising:

a processor configured to:

receive the signal used as the PPG signal;

obtain a time frequency spectrum of a segment of the signal used as the PPG signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum;

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining ~~hereinafter~~ referred to as a residual noise power;

determine a difference in frequency between the first trace and the second and third traces; the difference in frequency referred to as a projected difference;

apply a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if ~~noise/motion~~ motion and noise artifacts are not present, ~~the segment is included~~ include the segment in determination of a physiological parameter;

the noise quality index being a weighted sum of factors including the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

27. (Currently amended) The system of claim 18 wherein the processor is further configured to determine a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the signal used as the PPG signal in a time domain; the difference between the dominant frequency and the heart rate obtained from peak to peak intervals ~~hereinafter~~ referred to as a heart rate frequency difference; wherein the noise quality index also comprises the heart rate frequency difference; and, wherein the noise quality index is a weighted sum of factors including the residual noise power, the projected difference and the heart rate frequency difference.

30. (Currently amended) A system ~~system~~ for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal, the system comprising:

a processor configured to:

receive the signal used as the PPG signal;

obtain a time frequency spectrum of a segment of the signal used as the PPG signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum;

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining ~~hereinafter~~ referred to as a residual noise power;

determine a difference between the dominant frequency and a heart rate obtained from peak to peak intervals from the signal used as the PPG ~~or equivalent~~ signal in a time domain; the difference between the dominant frequency and the heart rate obtained from peak to peak intervals ~~hereinafter~~ referred to as a heart rate frequency difference;

the noise quality index being a weighted sum of factors including the residual noise power and the heart rate frequency difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

apply a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if ~~noise/motion~~ motion and noise artifacts are not present, ~~the segment is included~~ include the segment in determination of a physiological parameter.

35. (Currently amended) A computer program product comprising:

tangible computer usable media, having computer readable code embodied therein, the computer readable code, when executed by one or more processors, causes the one or more processors to:

obtain a time frequency spectrum of a segment of a signal used as a PPG signal;

obtain, from the time frequency spectrum, a noise quality index for the segment; the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

determine a dominant frequency in the time frequency spectrum of the segment;

normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

determine a first trace of amplitudes in ~~the~~ a narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

subtract the first, second and third traces of amplitudes from the time frequency spectrum; and

obtain, after subtracting, a total power remaining in the time frequency spectrum; the total power remaining ~~hereinafter~~ referred to as a residual noise power;

determine a difference in frequency between the first trace and the second and third traces; the difference in frequency referred to as a projected difference;

apply a statistical learning method, using the noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts;

and,

if ~~noise/motion~~ motion and noise artifacts are not present, ~~the segment is included~~ include the segment in determination of a physiological parameter;

wherein the noise quality index is a weighted sum of factors including the residual noise power and the projected difference; weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

Notice of Pre-AIA or AIA Status

2. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Amendment

3. This Office Action is responsive to the amendment filed 12/11/2018 ("Amendment"). Claims 1, 8, 10, 11, 13-18, 25, 27, 28, and 30-36 are currently under consideration. The Office acknowledges the amendments to claims 1, 8, 10, 13, 15, 16, 18, 25, 27, 30, 32, 33, and 35 (it being noted that claims 15 and 16 use the incorrect status indicator of "Original," and claim 25 uses incorrect amendment form by not underlining the addition of "18"), as well as the cancellation of claims 2-7, 9, 12, 19-24, 26, and 29. Further amendments have been made as shown above.

4. It is noted that the rejections based on use of the phrase "referred to as" have been reconsidered. The phrase is clear and does not necessarily make reference to subsequent claims. The rejections based on multiple uses of the phrase "a narrow band spectrum" have also been reconsidered because, throughout, the phrase is followed by features which distinguish it from other recitations. The claims are determined to be directed to patent eligible subject matter because the specific recitations of steps, as claimed, are directed to an improvement to the technology. As shown e.g. in Table II of the specification, the recited algorithm is an improved method of filtering motion and noise artifacts from a signal used as a PPG signal.

Reasons for Allowance

5. The following is an examiner's statement of reasons for allowance: the prior art of record fails to teach or fairly suggest a noise quality index from a time frequency spectrum, the noise quality index being based on a weighted sum of residual noise power, as specified,

and a projected different or a heart rate frequency difference, as specified, in combination with all other recited limitations.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ANDREY SHOSTAK whose telephone number is (408)918-7617. The examiner can normally be reached on Monday - Friday 9 am - 5 pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Marmor II can be reached on (571) 272-4730. 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.

/NAVIN NATNITHITHADHA/
Primary Examiner, Art Unit 3791

/ANDREY SHOSTAK/
Examiner, Art Unit 3791

Examiner-Initiated Interview Summary	Application No. 15/010,345	Applicant(s) Chon et al.		
	Examiner ANDREY SHOSTAK	Art Unit 3791	AIA (First Inventor to File) Status Yes	Page 1 of 1

All participants (applicant, applicants representative, PTO personnel):

1. ANDREY SHOSTAK (Examiner); Telephonic
2. Orlando Lopez (Attorney); Telephonic
3. Navin Natnithithadha(Primary Examiner: Consulted);

Date of Interview: 15 January 2019

Brief Description of the main topic(s) of discussion: The Examiner called to offer an examiner's amendment to place the claims in condition for allowance. The proposals were agreed to, except for the recitation of a display to attempt to direct the claims to a practical application. In a second conversation on 01/16/2019, and upon further consideration, all amendments were agreed to as reflected in the attached Examiner's Amendment (directed to eligible subject matter as an improvement to the technology).

Issues Discussed:

Proposed Amendments:
see above

/ANDREY SHOSTAK/ Examiner, Art Unit 3791	/NAVIN NATNITHITHADHA/ Primary Examiner, Art Unit 3791

Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04
Please further see:
MPEP 713.04
Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b)
37 CFR § 1.2 Business to be transacted in writing

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of 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.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/010,345	Chon et al.
	Examiner	Art Unit
	ANDREY SHOSTAK	3791

CPC - Searched*		
Symbol	Date	Examiner
A61B5/7207,1455,7267,725,7257,02416	09/05/2018	AS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor search in PALM and EAST	09/05/2018	AS
Text search in EAST	09/05/2018	AS
Classification search in EAST, limited by text and/or date	09/05/2018	AS

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
See listed classifications	EAST text search (see attached history)	01/17/2019	AS

/ANDREY SHOSTAK/ Examiner, Art Unit 3791	

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/010,345	Chon et al.
	Examiner	**Art Unit**
	ANDREY SHOSTAK	3791

CPC						
Symbol					**Type**	**Version**
A61B	/	5	/	7207	F	2013-01-01
A61B	/	5	/	02416	I	2013-01-01
A61B	/	5	/	7257	I	2013-01-01
A61B	/	5	/	1455	I	2013-01-01
A61B	/	5	/	725	I	2013-01-01
A61B	/	5	/	7267	I	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

/ANDREY SHOSTAK/ Examiner, Art Unit 3791 (Assistant Examiner)	17 January 2019 (Date)	**Total Claims Allowed:** 20	
/NAVIN NATNITHITHADHA/ Primary Examiner, Art Unit 3791 (Primary Examiner)	22 January 2019 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 6

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/010,345	Chon et al.
	Examiner	**Art Unit**
	ANDREY SHOSTAK	3791

INTERNATIONAL CLASSIFICATION				
CLAIMED				
A61B	/	5	/	02

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

/ANDREY SHOSTAK/ Examiner, Art Unit 3791	17 January 2019	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/NAVIN NATNITHITHADHA/ Primary Examiner, Art Unit 3791	22 January 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	6

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/010,345	Chon et al.
	Examiner	**Art Unit**
	ANDREY SHOSTAK	3791

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	18	19	35										
2	8	11	25	20	36										
3	10	12	27												
4	11	13	28												
8	13	17	30												
9	14	18	31												
5	15	14	32												
6	16	15	33												
7	17	16	34												

/ANDREY SHOSTAK/ Examiner, Art Unit 3791 (Assistant Examiner)	17 January 2019 (Date)	**Total Claims Allowed:** 20	
/NAVIN NATNITHITHADHA/ Primary Examiner, Art Unit 3791 (Primary Examiner)	22 January 2019 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 6

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/010,345	Chon et al.
	Examiner	Art Unit
	ANDREY SHOSTAK	3791

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

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/07/2018	01/17/2019							
	1	✓	=							
	2	✓	-							
	3	✓	-							
	4	✓	-							
	5	✓	-							
	6	✓	-							
	7	✓	-							
	8	✓	=							
	9	✓	-							
	10	✓	=							
	11	✓	=							
	12	✓	-							
	13	✓	=							
	14	✓	=							
	15	✓	=							
	16	✓	=							
	17	✓	=							
	18	✓	=							
	19	✓	-							
	20	✓	-							
	21	✓	-							
	22	✓	-							
	23	✓	-							
	24	✓	-							
	25	✓	=							
	26	✓	-							
	27	✓	=							
	28	✓	=							
	29	✓	-							
	30	✓	=							
	31	✓	=							
	32	✓	=							
	33	✓	=							
	34	✓	=							
	35	✓	=							
	36	✓	=							

Bibliographic Data

Application No: 15/010,345

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /ANDREY SHOSTAK/ Examiner's Signature | Initials

Title: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/29/2016	600	3791	30210-216
RULE			

APPLICANTS

INVENTORS

Ki H. Chon Worcester, MA, UNITED STATES

Jowoon Chong Worcester, MA, UNITED STATES

Duy Dao Malden, MA, UNITED STATES

Hamed Salehizadeh Worcester, MA, UNITED STATES

CONTINUING DATA

This application has PRO of 62109183 01/29/2015

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

02/24/2016

**** SMALL ENTITY ****

STATE OR COUNTRY

UNITED STATES

ADDRESS

BURNS & LEVINSON, LLP

125 SUMMER STREET

BOSTON, MA 02110

UNITED STATES

FILING FEE RECEIVED

$1,370

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	("20080287815").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 13:45
S2	9	("6862558" | "20050070774" | "20060200035" | "20060211930").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 13:46
S3	1	("20130172760").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 13:48
S4	1	("20130191035").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 13:51
S5	12	("20060122476" | "20090326349" | "20100016693" | "20080287815" | "20100298656").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 13:52
S6	1	("20130190638").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 13:56
S7	0	(("20110158259").PN.").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 13:57
S8	2	("20110158259").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 13:57
S9	1	("20160367198").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 13:59
S10	1	("20160361021").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 14:03
S11	16	("9713428" | "20140309943" | "9872652" | "8945017").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 14:04
S12	13	(chon with ki or chong with jowoon or dao with duy or salehizadeh with hamed).as,aanm,in. and (time adj frequency adj spectrum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2018/09/05 14:10

			DERWENT; IBM_TDB			
S13	2	("20080287815" | "20110077484").PN.	US-PGPUB; USPAT	OR	ON	2018/09/05 14:31
S14	42757	(A61B5/7207 or A61B5/1455 or A61B5/7267 or A61B5/725 or A61B5/7257 or A61B5/02416).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:08
S15	2	S14 and time adj frequency adj spectrum and ($5plethysmogra$4 or pleth or ppg) and motion with noise with artifact and support with vector with machine	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:12
S16	12	S14 and time adj frequency adj spectrum and ($5plethysmogra$4 or pleth or ppg) and motion with noise with artifact	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:12
S17	4	(("20120190947") or ("20130144180") or ("20130191035") or ("8755876")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/05 15:18
S18	16	S14 and time adj frequency adj spectr$2 and ($5plethysmogra$4 or pleth or ppg) and motion with noise with artifact	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:19
S19	4	S18 not S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:19
S20	16	(vfcdm or variable with frequency with complex with demodulation) with (tfs or time adj frequency adj spectr$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:22
S21	17	(vfcdm or variable with frequency with complex with demodulation) and ($5plethysmogra$4 or pleth or ppg)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/05 15:24
S22	42768	(A61B5/7207 or A61B5/1455 or A61B5/7267 or A61B5/725 or A61B5/7257 or A61B5/02416).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:06
S23	737	($5plethysmogra$4 or pleth or ppg) and (svm or support adj vector adj machine)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2018/09/06 08:18

			IBM_TDB			
S24	263	($5plethysmogra$4 or pleth or ppg) and (svm or support adj vector adj machine) and (motion with noise)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:18
S25	3	S24 and (time adj frequency adj spectr$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:19
S26	148	S24 and harmonic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:19
S27	2	S22 and noise adj quality adj index	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:20
S28	30	S26 and total adj power	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:22
S29	4	S22 and projected adj difference	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:28
S30	4	S22 and residual adj noise adj power	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 08:31
S31	128	extract with trace with power	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:38
S32	340	extract$3 with trace with power	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:38
S33	16	extract$3 with trace with power with noise	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2018/09/06 09:39

			IBM_TDB			
S34	362	extract$3 with (band or scale) with power with noise	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:40
S35	623	(extract$3 or subtract$3) with (band or scale) with power with noise	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:41
S36	403	(extract$3 or subtract$3) with (band or scale) with (fundamental or dominant) adj frequency	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:41
S37	5	(extract$3 or subtract$3) with (band or scale) with (fundamental or dominant) adj frequency same noise same power	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:42
S38	10	(extract$3 or subtract$3) with (band or scale) with (fundamental or dominant) adj frequency and ($5plethysmogra$4 or pleth or ppg)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 09:42
S39	1	("20160022164").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/09/06 10:06
S40	16	"2013043157"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:28
S41	24	heart adj rate with frequency adj difference	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:57
S42	356	heart adj rate with frequency with difference	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 10:59
S43	14	heart adj rate with time adj domain with (dominant or fundamental) adj frequency	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 11:00
S44	44	heart adj rate with harmonic same (spectrogram or scalogram)	US-PGPUB; USPAT;	OR	ON	2018/09/06 13:29

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S45	0	(fundamental or dominant) with frequency same peak adj to adj peak with interval	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 15:18
S46	0	(fundamental or dominant) with frequency same peak adj to adj peak	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 15:18
S47	1674	(fundamental or dominant) with frequency same peak adj3 peak	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 15:18
S48	63	(fundamental or dominant) with frequency same peak adj3 peak with interval	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 15:18
S49	39	(fundamental or dominant) with frequency same peak adj3 peak with interval with frequency	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 15:19
S50	57	noise adj3 quality adj3 index	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/06 15:24
S51	576	heart adj rate with spectr$2 same2 heart adj rate with interval	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/07 07:03
S52	86	heart adj rate with spectr$2 same heart adj rate with interval same (difference or compar$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/07 07:12
S53	4	heart adj rate with spectr$2 same heart adj rate with interval same (difference or compar$4) same noise	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/07 07:17
S54	179	noise same heart adj rate same (frequency with differen$3 or	US-PGPUB; USPAT;	OR	ON	2018/09/07 09:26

		projected adj differen$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S55	97	noise same heart adj rate with (frequency with differen$3 or projected adj differen$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/07 09:27
S56	1	noise same (heart or pulse) adj rate with differen$3 with (time adj domain or peak adj3 peak or interval) with (frequency adj domain or (dominant or fundamental) with frequency)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/07 10:12

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	((ppg or pleth or $5plethysmogra$4) same frequency same (noise or artifact) same power same weight$3 same index).clm.	US-PGPUB; USPAT	OR	ON	2019/01/17 15:57

1/17/2019 3:58:22 PM
C:\Users\ashostak\Documents\EAST\Workspaces\15010345 - 9.5.18 - motion and noise artifact detection and reconstruction algorithms for photoplethysmogram and equivalent signals.wsp

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.
15/010,345	01/29/2016	Ki H. Chon	30210-216	2095

26486 7590 03/13/2019

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

EXAMINER	
SHOSTAK, ANDREY	

ART UNIT	PAPER NUMBER
3791	

NOTIFICATION DATE	DELIVERY MODE
03/13/2019	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

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Application No. : 15010345
Applicant : Chon
Filing Date : 01/29/2016
Date Mailed : 03/13/2019

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Notice of Allowance Mailed

This application has been accorded an Allowance Date and is being prepared for issuance. The application, however, is incomplete for the reasons below.

Applicant is given two (2) months from the mail date of this Notice within which to respond. This time period for reply is extendable under 37 CFR 1.136(a) for only TWO additional MONTHS.

The informalities requiring correction are indicated in the attachment(s). If the informality pertains to the abstract, specification (including claims) or drawings, the informality must be corrected with an amendment in compliance with 37 CFR 1.121 (or, if the application is a reissue application, 37 CFR 1.173). Such an amendment may be filed after payment of the issue fee if limited to correction of informalities noted herein. See Waiver of 37 CFR 1.312 for Documents Required by the Office of Patent Publication, 1280 Off. Gaz. Patent Office 918 (March 23, 2004). In addition, if the informality is not corrected until after payment of the issue fee, for purposes of 35 U.S.C. 154(b)(1)(iv), "all outstanding requirements" will be considered to have been satisfied when the informality has been corrected. A failure to respond within the above-identified time period will result in the application being ABANDONED.

See attachment(s).

A copy of this notice MUST be returned with the reply. Please address response to "Mail Stop Issue Fee, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450".

/Meriem Powell/
Publication Branch
Office of Data Management
(571) 272-4200

Application No. 15010345 **Drawings filed: 12/11/2018**

IDENTIFICATION OF DRAWING DEFICIENCIES

- ☐ There is a hole or the image thereof within the illustration. FIG(s)
- ☐ The illustration is penetrated or traversed by a solid or broken line that is not intended to be part of the drawing, such as a dark line caused by a flaw in the copying process. FIG(s)
- ☐ An ink stamp or the image thereof obscures part of the illustration. FIG(s)
- ☐ The drawing is marred by black smudges, obliterations, or fax/copier marks (for example, speckles or dots in a substantial portion of the drawing). FIG(s)
- ☐ Figure numbers are duplicated or missing. FIG(s)
- ☐ Drawing sheet or figure is missing. FIG(s)
- ☐ Numbers, letters, or reference characters in the drawing have been crossed out or are illegibly handwritten. FIG(s)
- ☐ The character of the lines, numbers, and letters is poor. FIG(s)
- ☐ The drawing's background shows that the original drawing was made on graph paper or other paper with a pattern or decoration. FIG(s)
- ☐ The FIG. number label is placed in a location that causes the drawing to be read upside down. FIG(s)
- ☐ Data, a reference number, or part of the drawing is truncated or missing, or a lead line has no reference number. FIG(s)
- ☐ The drawing and/or the FIG. label contain(s) foreign language. FIG(s)
- ☐ This utility application contains a photograph of a view that is capable of being illustrated as a line drawing. FIG(s)
- ☐ A petition under 37 CFR 1.84(a)(2) to accept color drawings has been granted, but the brief description of the drawings in the specification does not contain (or has not been amended to contain) the paragraph required by 37 CFR 1.84(a)(2)(iii).
- ☐ This reissue application contains added and/or amended drawings that are not labeled as “New” or “Amended” or “Canceled” as required by 37 CFR 1.173(b)(3). FIG(s)
- ☐ This Design reissue application contains a drawing that is labeled as “Canceled” but is not surrounded by brackets, or a drawing that is surrounded by brackets but is not labeled as “Canceled.” See 37 CFR 1.173(b)(3). FIG(s)
- ☐ OTHER:
- ☒ COMMENTS:
  Drawings filed 12/11/18 contain a replacement sheet for FIG(s) 1B and 1D but did not include FIG(s) 1A and 1C. Per 37 CFR 1.121(d) the replacement sheet shall include all of the figures appearing on the immediate prior version, even if only one figure is being amended.

PTO/AIA/80 (07-17)
Approved for use through 01/31/2018. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no person is required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

[X] Practitioners associated with Customer Number: 26486

OR

[ ] Practitioner(s) named below (If more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

[X] The address associated with Customer Number: 26486

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: Worcester Polytechnic Institute
100 Institute Road, Worcester, Massachusetts 01619

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee.

Signature	Date
Name Todd Keiller	Telephone
Title Director of Intellectual Property and Innovation	

This collection of information is required by 37 CFR 1.31, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public, which is to update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 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.

PTO/AIA/01 (06-12)
Approved for use through 11/30/2020. 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.

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

Title of Invention	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 15/010,345

filed on 01-29-2016.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Ki H. Chon Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1.11 and 1.14. This collection is estimated to take 1 minute 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.

PTO/AIA/01 (06-12)
Approved for use through 11/30/2020. 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.

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

Title of Invention	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 15/010,345 filed on 01-29-2016.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Hamed Selehizadeh Date (Optional): 03/19/2019

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1.11 and 1.14. This collection is estimated to take 1 minute 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.

PTO/AIA/01 (06-12)
Approved for use through 11/30/2020. 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.

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

Title of Invention	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 15/010,345

filed on 01-29-2016.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Duy Dao Date (Optional): 04/09/17

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1.11 and 1.14. This collection is estimated to take 1 minute 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.

Doc code: Oath
Document Description: Oath or declaration filed

PTO/AIA/02 (07-13)
Approved for use through 11/30/2020. 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.

SUBSTITUTE STATEMENT IN LIEU OF AN OATH OR DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (35 U.S.C. 115(d) AND 37 CFR 1.64)

Title of Invention	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

This statement is directed to:

☐ The attached application,

OR

☒ United States application or PCT international application number 15/010,345 filed on 01-29-2016.

LEGAL NAME of inventor to whom this substitute statement applies:

(*E.g.*, Given Name (first and middle (if any)) and Family Name or Surname)

Jo Woon Chong

Residence (except for a deceased or legally incapacitated inventor):

City	State	Country
Lubbock	TX	US

Mailing Address (except for a deceased or legally incapacitated inventor):

Texas Tech University 2500 Broadway

City	State	Zip	Country
Lubbock	TX	79409	US

I believe the above-named inventor or joint inventor to be the original inventor or an original joint inventor of a claimed invention in the application.

The above-identified application was made or authorized to be made by me.

I hereby acknowledge that any willful false statement made in this statement is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

Relationship to the inventor to whom this substitute statement applies:

- ☐ Legal Representative (for deceased or legally incapacitated inventor only),
- ☒ Assignee,
- ☐ Person to whom the inventor is under an obligation to assign,
- ☐ Person who otherwise shows a sufficient proprietary interest in the matter (petition under 37 CFR 1.46 is required), or
- ☐ Joint Inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1.11 and 1.14. This collection is estimated to take 1 minute 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.

PTO/SB/AIA02 (07-13)
Approved for use through 11/30/2020. 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.

SUBSTITUTE STATEMENT

Circumstances permitting execution of this substitute statement:

- ☐ Inventor is deceased,
- ☐ Inventor is under legal incapacity,
- ☒ Inventor cannot be found or reached after diligent effort, or
- ☐ Inventor has refused to execute the oath or declaration under 37 CFR 1.63.

If there are joint inventors, please check the appropriate box below:

- ☒ An application data sheet under 37 CFR 1.76 (PTO/AIA/14 or equivalent) naming the entire inventive entity has been or is currently submitted.

OR

- ☐ An application data sheet under 37 CFR 1.76 (PTO/AIA/14 or equivalent) has not been submitted. Thus, a Substitute Statement Supplemental Sheet (PTO/AIA/11 or equivalent) naming the entire inventive entity and providing inventor information is attached. See 37 CFR 1.64(b).

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

PERSON EXECUTING THIS SUBSTITUTE STATEMENT:

Name: Todd S. Keiller | Date (Optional):

Signature: Todd Keil

APPLICANT NAME AND TITLE OF PERSON EXECUTING THIS SUBSTITUTE STATEMENT:

If the applicant is a juristic entity, list the applicant name and the title of the signer:

Applicant Name: Worcester Polytechnic Institute

Title of Person Executing This Substitute Statement: Director, Intellectual Property and Innovation

The signer, whose title is supplied above, is authorized to act on behalf of the applicant.

Residence of the signer (unless provided in an application data sheet, PTO/AIA/14 or equivalent):

City Worcester | State MA | Country US

Mailing Address of the signer (unless provided in an application data sheet, PTO/AIA/14 or equivalent)

100 Institute Road Worcester, MA 01609

City Worcester | State MA | Zip 01609 | Country US

Note: Use an additional PTO/AIA/02 form for each inventor who is deceased, legally incapacitated, cannot be found or reached after diligent effort, or has refused to execute the oath or declaration under 37 CFR 1.63.

Electronic Acknowledgement Receipt

EFS ID:	35951163
Application Number:	15010345
International Application Number:	
Confirmation Number:	2095
Title of Invention:	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS
First Named Inventor/Applicant Name:	Ki H. Chon
Customer Number:	26486
Filer:	Orlando Lopez/Susan Jones Oujli
Filer Authorized By:	Orlando Lopez
Attorney Docket Number:	30210-216
Receipt Date:	08-MAY-2019
Filing Date:	29-JAN-2016
Time Stamp:	12:05:08
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	Miscellaneous Incoming Letter	30210-216_ResponseNoticeFileCorrected.pdf	67503 e775c4f9ad3cbc8c4761945e65c70e1f10e257cb	no	1

Warnings:

Information:					
2	Drawings-only black and white line drawings	30210-216US_ReplacementFigures1A1C.pdf	78132 b796fdf2f9fb37e987a854bacd3e03075d57af91	no	2
Warnings:					
Information:					
3	Application Data Sheet	30210-216_CorrectedADS.pdf	511331 997e61ee1449e357246a8d675fbd867bab9a1724	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
4	Assignee showing of ownership per 37 CFR 3.73	30210-216_Statement373.pdf	117937 88c4d618dd5886ca501b9382db9ed03d4dd330bb	no	3
Warnings:					
Information:					
5	Power of Attorney	4706_001.pdf	769129 1ec518e1b3e1393f39fab7deab1bd0df0d2a75ca	no	1
Warnings:					
Information:					
6	Oath or Declaration filed	4705_001.pdf	4391159 b0c9f440d80a676d7b80ce87de73cb9ed1fef8da	no	5
Warnings:					
Information:					
			Total Files Size (in bytes):	5935191	

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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Ki H. Chon
Application No.: 15/010,345
Filed: 01-29-2016
Title: MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS

Confirm. No.: 2095
Group Art Unit: 3791
Examiner: SHOSTAK, ANDREY

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

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

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS AFTER NOTICE OF ALLOWANCE

Sir:

In reply to the Notice to File Corrected Application Papers dated March 13, 2019, requesting submission of replacement drawings, please find enclosed 2 sheets of replacement drawings consisting of Figs. 1A and 1C for filing in the above-captioned application. No new matter has been added to these drawings.

The Director of Patents and Trademarks is hereby authorized to charge any deficiencies, or credit any overpayment, to Deposit Account No.03-2410, Order No. 30210-216.

Dated: May 8, 2019

Respectfully submitted,

By: /Orlando Lopez/
Orlando Lopez
Registration No.: 46,880
Customer No.: 26486
Attorney for Applicant

4822-0434-2421.1

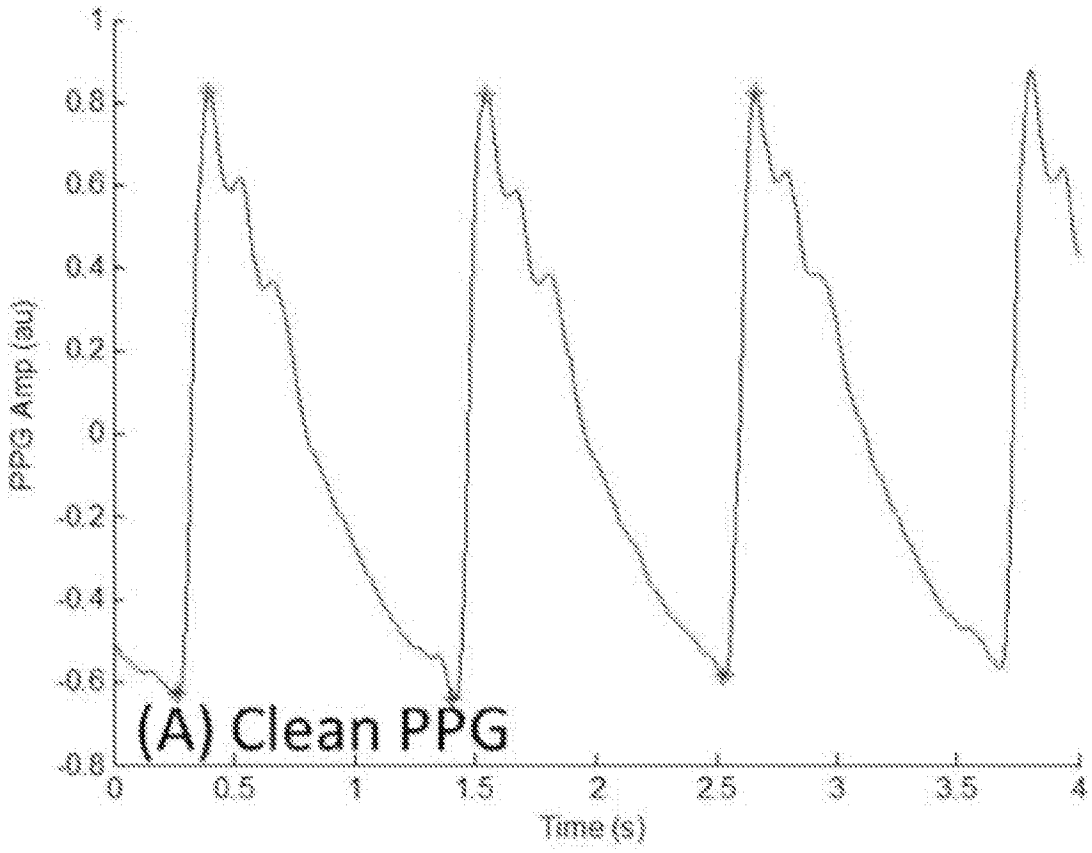

PPG Amp (au)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (s)
(A) Clean PPG

FIG. 1A

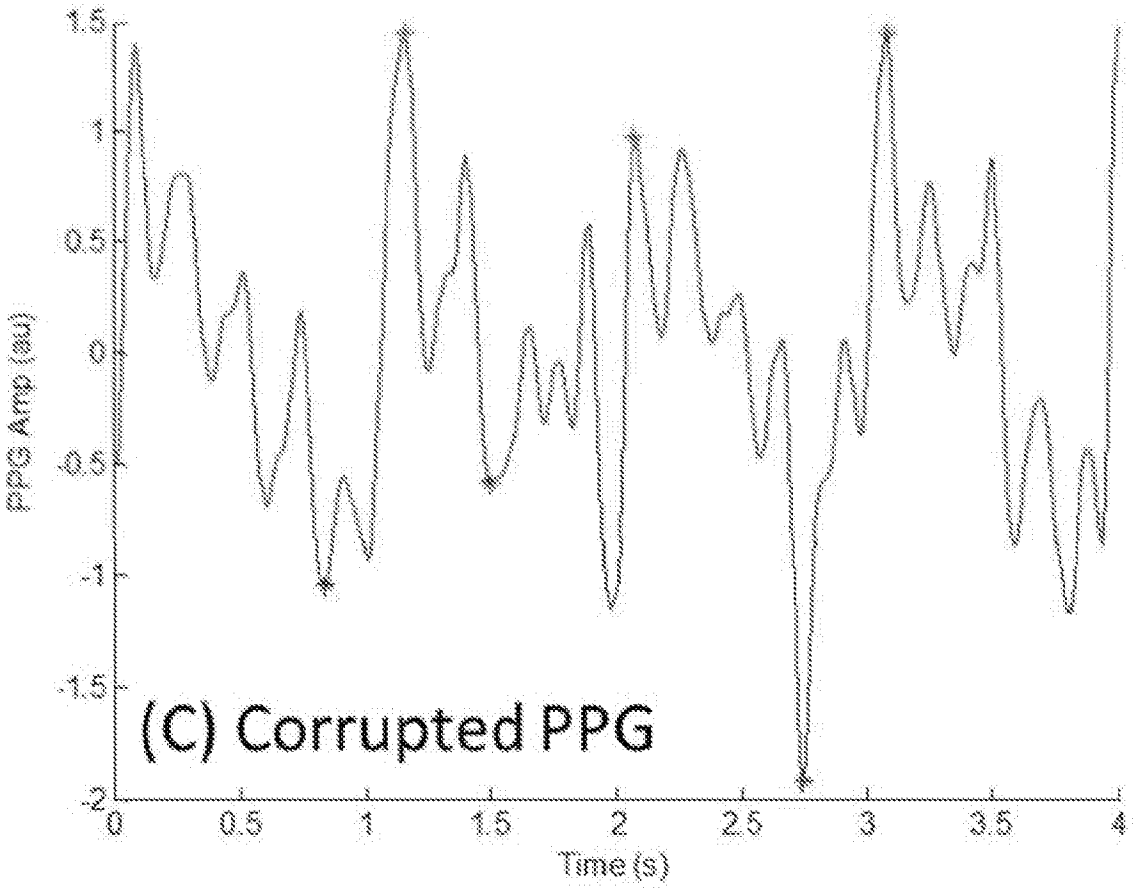

PPG Amp (au)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
0.5
1
1.5
2
2.5
3
3.5
4
Time (s)
(C) Corrupted PPG

FIG. 1C

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. 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 contains a valid OMB control number.

CORRECTED

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	30210-216
	Application Number	**15/010,345**
Title of Invention	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS	

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.

Secrecy Order 37 CFR 5.2

☐ 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.)

Inventor Information:

Inventor 1 Remove

Legal Name

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	US

Mailing Address of Inventor:

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

City	Worcester	State/Province	MA
Postal Code	01609	**Country**	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jowoon		Chong	

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

City	Worcester	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

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

City	Worcester	State/Province	MA
Postal Code	01609	**Country**	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Duy		Dao	

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

PTO/AIA/14 (03-13)
Approved for use through 01/31/2014. 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 contains a valid OMB control number.

CORRECTED

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	30210-216
	Application Number	**15/010,345**
Title of Invention	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS	

City	Malden	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

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

City	Worcester	State/Province	MA
Postal Code	01609	**Country**	US

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Hamed		Salehizadeh	

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

City	Worcester	State/Province	MA	Country of Residence	US

Mailing Address of Inventor:

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

City	Worcester	State/Province	MA
Postal Code	01609	**Country**	US

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

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **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	MOTION AND NOISE ARTIFACT DETECTION AND RECONSTRUCTION ALGORITHMS FOR PHOTOPLETHYSMOGRAM AND EQUIVALENT SIGNALS		
Attorney Docket Number	30210-216	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	8	**Suggested Figure for Publication (if any)**	