

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZEPP HEALTH CORPORATION

Petitioner

v.

WORCESTER POLYTECHNIC INSTITUTE

Patent Owner

Case No. IPR2025-00521

U.S. Patent No. 10,653,362

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,653,362**

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LIST OF EXHIBITS¹

Ex-1001	U.S. Pat. No. 10,653,362 (“the ‘362 Patent” or “the Patent”)
Ex-1002	Declaration of Dr. George E. Yanulis
Ex-1003	Curriculum Vitae of Dr. George E. Yanulis
Ex-1004	Prosecution History of the ‘362 Patent
Ex-1005	U.S. Patent Application Publication No. 2012/0190947, filed on January 20, 2012, and published on July 26, 2012 (“Chon ‘947”)
Ex-1006	U.S. Patent Application Publication No. 2010/0049267, filed on August 21, 2009, and published on February 25, 2010 (“Mollerus”)
Ex-1007	U.S. Patent Application Publication No. 2005/0033129, filed on June 22, 2004, and published on February 10, 2005 (“Edgar”)
Ex-1008	K.H. Chon et al., <i>Estimation of Respiratory Rate from Photoplethysmogram Data Using Time-Frequency Spectral Estimation</i> , IEEE Transactions on Biomedical Engineering, Volume 56, No. 8, pp. 2054-63 (April 14, 2009) (“Chon 2009”)
Ex-1009	U.S. Patent No. 8,918,178, filed on September 5, 2012, and patented on December 23, 2014 (“Simon”)
Ex-1010	Declaration of Dr. Sylvia D. Hall-Ellis
Ex-1011	Zepp Health Corporation’s Stipulation Regarding Invalidity Challenges
Ex-1012	Docket Control Order (Dkt. 58) in <i>Research Foundation for The State University of New York v. Xiaomi Corporation et al.</i> , No. 2:23-cv-00353-RWS-RSP (E.D. Tex.)
Ex-1013	Judge Robert W. Schroeder, III (E.D. Tex.) – Calendar Events Set for 2/17/2026
Ex-1014	Judge Robert W. Schroeder, III (E.D. Tex.) – Case Statistics
Ex-1015	Docket entries in <i>Research Foundation for The State University of New York v. Xiaomi Corporation et al.</i> , No. 2:23-cv-00353-RWS-RSP (E.D. Tex.)

¹ In this Petition, 4-digit pin citations that begin with “0” refer to the branded numbers added by Petitioner in the bottom right corner of the exhibits. All other pin citations in this Petition refer to original page, column, paragraph, or line numbers.

I. INTRODUCTION

Zepp Health Corporation (“Petitioner”) requests inter partes review (“IPR”) of Claims 1-20 of U.S. Patent No. 10,653,362 (“the ‘362 Patent” or “Patent”) (Ex-1001), currently owned by Worcester Polytechnic Institute.

II. MANDATORY NOTICE UNDER 37 C.F.R. §42.8

Real Parties-in-Interest:

Petitioner identifies the following real party-in-interest: Zepp Health Corporation.

Related Matters:

- *Research Foundation for The State University of New York, University of Connecticut, and Worcester Polytechnic Institute v. Xiaomi Corporation, Xiaomi Communications Co., Ltd., Xiaomi H.K., Ltd., Xiaomi, Inc., and Zepp Health Corporation*, No. 2:23-cv-00353-RWS-RSP (E.D. Tex.) (the “Related Litigation”)
- *Research Foundation for The State University of New York, University of Connecticut, and Worcester Polytechnic Institute v. Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., Samsung Austin Semiconductor, LLC, and Samsung Semiconductor, Inc.*, No. 2:23-cv-00141-RWS-RSP (E.D. Tex.)

- *Research Foundation for The State University of New York, University of Connecticut, and Worcester Polytechnic Institute v. Huawei Device Co., Ltd.*, No. 2:23-cv-00553-RWS-RSP (E.D. Tex.)

Lead and Back-Up Counsel, and Service Information

Pursuant to 37 C.F.R. §§ 42.8(b)(3)-(4), Petitioner identifies its counsel as follows. Petitioner consents to electronic service at the counsel's email addresses below.

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III. FEE AUTHORIZATION

The Office is authorized to charge all fees due for this proceeding to Deposit Account No. 502075.

IV. GROUNDS FOR STANDING

Pursuant to 37 C.F.R. § 42.104(a), Petitioner certifies that the ‘362 Patent is available for *inter partes* review, and that Petitioner is not barred or estopped from requesting an *inter partes* review of the challenged claims on the grounds identified in the petition.

V. IDENTIFICATION OF CHALLENGE

Pursuant to 37 C.F.R. § 42.104(b), Petitioner requests review and cancellation of Claims 1-20 of the ‘362 Patent pursuant to the following statement of precise relief requested.

- **Ground 1:** Claims 1, 3, 5-8, 10, 12, 14-17 and 19 are rendered obvious by U.S. Patent Publication No. 2012/0190947 to Chon (“Chon ‘947”; Ex-1005) in view of U.S. Patent Publication No. 2010/0049267 to Mollerus (“Mollerus”; Ex-1006) under 35 U.S.C. § 103 (AIA).
- **Ground 2:** Claims 2, 4, 9, 11, 13, 18 and 20 are rendered obvious by Chon ‘947 in view of Mollerus and further in view of U.S. Patent No. 8,918,178 (“Simon”; Ex-1009) under 35 U.S.C. § 103 (AIA).

VI. THE CHALLENGED PATENT

The '362 Patent describes systems and methods for obtaining physiological signals, such as PPG, EKG signals, and detecting motion and noise artifacts (MNA) in Photoplethysmogram (PPG) signals or equivalent signals. Ex-0001 3:13-21. The '362 Patent involves obtaining the time-frequency spectrum of a PPG signal segment, deriving a noise quality index (NQI) from the spectrum, and using statistical learning techniques, such as Support Vector Machines (SVM), to classify whether the segment is corrupted by motion artifacts. *Id.*, 3:22-23. The specification includes various feature extraction techniques to quantify noise, such as residual noise power, frequency modulation differences, and heart rate frequency differences. *Id.*, 5:6-12. These features are then combined into a noise quality index, which helps in determining whether to retain or discard the segment in the final physiological measurements. *Id.*, 4:44-48.

The '362 Patent uses a processor that applies these methods for real-time artifact detection. *Id.*, 3:24-32. The patent classifies segments as clean or corrupted by motion artifacts by leveraging machine learning techniques, specifically SVM, thus improving the reliability of heart rate and oxygen saturation readings in dynamic environments. *Id.*, 9:46-51. The patent then compares PPG data from both healthy subjects and patients in controlled and real-world conditions, showing that the method offers high sensitivity and specificity in detecting motion artifacts, with

significant potential for accurate physiological monitoring during activities involving body movements. *Id.*, 12:30-35.

Further, the ‘362 patent discloses using an MNA detection method that uses dynamic characteristics of the corrupted PPG derived via the VFCDM (Variable Frequency Distribution Covariance Matrix) to generate a high-resolution time-frequency spectrum of the PPG signal, enabling detection of MNA by calculating a Noise Quality Index. *Id.*, 6:30-45. The VFCDM is a time-frequency analysis technique commonly used in physiological signal processing.

VII. PROSECUTION HISTORY OF THE ‘362 PATENT

In the non-final office action, the examiner rejected multiple claims under 35 U.S.C. § 102(a)(1) and § 103, citing various prior art references, including US Patent Application Publication 2011/0077484 (“Van Slyke”), US Patent 5,853,364 (“Baker”), International Patent Publication WO 2013/043157 (“Brockway”), and others. Ex-1004 (0119-0126), 2018-09-14 Office Action.

Specifically, claims 1, 2, 15, 16, 18, 19, 32, 33, and 35 were rejected under § 102(a)(1) for anticipation by Van Slyke, while Claims 3, 4, 6, 20, 21, and 23 were rejected under § 103 for obviousness based on Van Slyke in combination with Baker and Brockway. *Id.* at 0121-0124. Additionally, claims 5 and 22 were rejected for obviousness over the same references plus *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”). *Id.* at 0124. The examiner also issued rejections for other claims based on different combinations of prior art. *Id.* at 0124-0126.

In response, the applicant amended the claims to overcome the § 102 rejection by adding limitations related to the determination of a noise quality index and residual noise power. *Id.* (0237-0238; 0253-0254; 0268-0276), 2018-12-11 Response to Office Action. The applicant also canceled Claims 2 and 19 and several others to address the § 103 rejections. *Id.* at 0268-0276. The claims were eventually allowed. *Id.* at 0440-0445.

Further, the prior art for the invalidity grounds in this Petition was not presented during the prosecution of the ‘362 Patent.

Also, the arguments for the invalidity grounds in this Petition were not presented during the prosecution of the ‘362 Patent.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (“POSITA”) at the time of the purported invention of the ‘362 Patent would have had a working knowledge of physiological monitoring technologies and/or signal processing as used in physiological monitoring technologies. The POSITA would have had a bachelor’s degree in an academic discipline related to electrical, computer, software, optical, or biomedical technologies, in combination with two years of work experience related to the

capture and processing of data or information signals, or designing and using biomedical sensors or systems, including but not limited to physiological monitoring technologies. Alternatively, a POSITA would have had a master's degree in one of the above academic disciplines with one year of work experience as described above. Additional education can substitute work experience, and vice versa. The proposed level of skill for the POSITA would not change if a different priority of the invention date is found. Ex-1002 ¶14.

IX. PRIORITY DATE

The '362 Patent claims priority to provisional application No. 62/109,183 filed on January 29, 2015. While the earliest possible priority date that the patent owner may claim for the '362 Patent is based on that provisional application's filing date of January 29, 2015, Petitioner does not concede that any claim of the Patent is entitled to that priority date. Regardless, all applied prior art references asserted in this Petition are U.S. patent publications that were filed and published before that priority date (earliest possible effective filing date of the '362 Patent), and thus qualifies as prior art under AIA 35 U.S.C. §§ 102(a)(1), 102(a)(2) and 103.

X. CLAIM CONSTRUCTION

Petitioner interprets the claim terms of the Patent according to the *Phillips* claim construction standard. 37 C.F.R. §42.100(b). Petitioner applies the plain and

ordinary meaning to each claim term of the Patent as it would have been understood by a POSITA.

Further, the parties have not yet submitted claim construction contentions in the district court litigation. Petitioner respectfully reserves all rights to raise claim construction and other arguments in the district court litigation.

XI. BRIEF DESCRIPTION OF THE APPLIED PRIOR ART

The claims of the ‘362 Patent do not identify anything new or significantly different from what was already known to those skilled in the art before the earliest possible priority date of the ‘362 Patent. Ex-1002 ¶45.

A. Chon ‘947 (Ex-1005)

Chon ‘947 is titled “Physiological parameter monitoring with a mobile communication device.” Chon ‘947 was filed on January 20, 2012 and published on July 26, 2012, several years before the ‘362 Patent’s earliest possible priority date (effective filing date) of January 29, 2015. Chon ‘947 is thus prior art to the ‘362 Patent under AIA 35 U.S.C. §§ 102(a)(1), 102(a)(2) and 103.

Chon ‘947 describes a method for detecting motion artifacts in physiological signals, particularly in photoplethysmogram (PPG) data, by analyzing the effects of motion on the measurements of physiological parameters such as heart rate and blood oxygen levels. Chon ‘947 (Ex-1005) Abstract. In the method outlined, the physiological indicator signal, such as that from a PPG sensor, is processed by a

mobile communication device to identify and assess the presence of motion artifacts in the signal. Chon ‘947 (Ex-1005) [0008]-[0010]. Preprocessing of the signal involves segmenting the data and evaluating its volatility, which is quantified using indicators such as kurtosis and Shannon entropy. *Id.* [0037]-[0038]. If the values of these indicators fall outside predetermined thresholds, the segment is considered corrupted by motion artifacts and is discarded. *Id.* [0037]. However, if the data segment passes this test, it is retained for further analysis, such as the calculation of physiological parameters. *Id.*

As part of the artifact detection methodology, the signal is further analyzed using time-frequency spectrum analysis, where the amplitude modulation within the heart rate frequency band is evaluated to determine the severity of noise contamination. *Id.* [0045]. If the level of noise in a segment falls within an acceptable range, the data is considered usable for clinical analysis, such as detecting blood loss. The use of kurtosis, Shannon entropy, and time-frequency spectral analysis allows for a nuanced approach to differentiating between clean and corrupted data, ensuring the integrity of measurements in real-world conditions. *Id.* [0050]-[0065]; Ex-1002 ¶¶46-48.

B. Mollerus (Ex-1006)

Mollerus is titled “Implanted medical device.” Mollerus was filed on August 21, 2009 and published on February 25, 2010, several years before the ‘362 Patent’s

earliest possible priority date (effective filing date) of January 29, 2015. Mollerus is thus prior art to the '362 Patent under AIA 35 U.S.C. §§ 102(a)(1), 102(a)(2) and 103.

Mollerus describes the integration of spectral fingerprint techniques in implantable medical devices such as pacemakers and implantable cardioverter defibrillators (ICDs). Mollerus (Ex-1006) [0032]. These devices analyze raw signal data from ventricular electrodes to classify waveforms, distinguishing between physiological events like ventricular fibrillation (VF) and non-physiological artifacts such as electromagnetic interference (EMI) or lead noise. *Id.* [0009]. The device processes signals in both the time and frequency domains, using advanced techniques such as Fourier transforms and wavelet packet analysis to separate true arrhythmic events from noise or artifacts. *Id.* Mollerus emphasizes the importance of this analysis in improving the accuracy of arrhythmia detection and preventing unnecessary treatments, such as shocks, when signals are misidentified due to noise or supraventricular tachycardia (SVT). *Id.* [0027]-[0029]. By leveraging spectral fingerprinting, the device can adapt its response, either proceeding with shock delivery or switching to safer pacing modes if the detected rhythm is determined to be artifact-based. *Id.* [0007].

Mollerus addresses this issue by describing how the ICD or pacemaker adjusts its computational power when a high ventricular rate is detected. Mollerus (Ex-1006)

[0009]-[0010]. In such cases, the device activates additional layers of signal analysis to enhance the classification accuracy and differentiate between pathologic arrhythmias and noise. *Id.* [0009]-[0010]. The use of spectral techniques, such as Shannon entropy and energy ratios from the first few harmonics of the signal, allows the device to robustly identify true arrhythmic signatures while minimizing the impact of motion or external interference. *Id.* [0035]; Ex-1002 ¶¶49-51.

C. Simon (Ex-1009)

Simon is titled “Non-invasive vagal nerve stimulation to treat disorders.” Simon was filed on September 5, 2012, and patented on December 23, 2014 (“Simon”), before the ‘362 Patent’s earliest possible priority date (effective filing date) of January 29, 2015. Simon is thus prior art to the ‘362 Patent under AIA 35 U.S.C. §§ 102(a)(1), 102(a)(2) and 103.

Simon disclose devices, systems and methods for treating a variety of diseases and disorders, involving the use of an energy source comprising magnetic and/or electrical energy that is transmitted non-invasively to, or in close proximity to, a selected nerve to temporarily stimulate, block and/or modulate the signals in the selected nerve such that neural pathways are activated to release inhibitory neurotransmitters in the patient's brain. Ex-1009 Abstract. It discloses the use of a support vector machine (“SVM”), which is an “algorithmic approach to the problem of classification within the larger context of supervised learning.” *Id.* at 69:22-23.

“A number of classification problems . . . have been found to be more easily solvable by SVMs.” *Id.* at 69:23-27; Ex-1002 ¶¶52-53.

XII. GROUND 1: CLAIMS 1, 3, 5-8, 10, 12, 14-17 AND 19 ARE RENDERED OBVIOUS BY CHON ‘947 IN VIEW OF MOLLERUS

Claims 1, 3, 5-8, 10, 12, 14-17 and 19 of the ‘362 Patent are rendered obvious by Chon ‘947 (Ex-1005) in view of Mollerus (Ex-1006) under 35 U.S.C. § 103 (AIA), as supported by the declaration of Dr. George E. Yanulis. Ex-1002.

A. A POSITA would have been motivated to combine the teachings of Chon ‘947 with Mollerus’s teachings, and would have had a reasonable expectation of success in doing so

A POSITA would have been motivated to combine the teachings of Chon ‘947 (Ex-1005) with Mollerus’s teachings (Ex-1006), and would have had a reasonable expectation of success in doing so because each relates to physiological measurement and monitoring. *See, e.g.*, Ex-1005 [0007]-[0010]; Ex-1006 [0002], [0028] & [0035]; Ex-1002 ¶¶55-62. In particular, both references disclose techniques that address motion and noise artifacts removals. Both references were also published one after another very closely in time—Chon ‘947 was published on July 26, 2012, and Mollerus was published in February 25, 2010. For instance, a POSITA reviewing the Chon ‘947 reference in 2012 would have had Mollerus readily available as a reference. *Id.*

A POSITA would have been motivated to combine the teachings of Chon ‘947 and Mollerus due to a shared focus on improving the accuracy and reliability of

physiological measurements in the presence of motion artifacts. *Id.* ¶56. By leveraging Mollerus’s teachings on motion and noise artifact detection, the algorithms in Chon ‘947 could be enhanced to more accurately differentiate between motion artifacts and valid physiological data in real-time, improving the overall performance of mobile health monitoring systems. *Id.*

In particular, Mollerus’s ability to distinguish different types of noise using advanced signal processing techniques could be readily and feasibly integrated into Chon ‘947’s motion and noise artifact detection approach to create an even more robust and reliable system that can better withstand various sources of interference—whether they come from external movements or electrical noise. *Id.* ¶60.

Moreover, the POSITA would have had a reasonable expectation of success in combining Chon ‘947 with Mollerus, as they were both directed to motion and noise artifact reduction in the context of physiological measurements, specifically using devices like pulse oximeters or similar sensors. *Id.* ¶61.

B. Independent claims 1, 8, 10, 17 and 19 are rendered obvious by Chon ‘947 in view of Mollerus

Claims 1, 8, 10, 17 and 19 (all independent claims) of the ‘362 Patent are rendered obvious by Chon ‘947 (Ex-1005) in view of Mollerus (Ex-1006) under AIA 35 U.S.C. § 103, as supported by the declaration of Dr. George E. Yanulis. Ex-1002.

1. Preambles

[1Pre] A computer implemented method for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:	[8Pre] A computer implemented method for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:	[10Pre] A system for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the system comprising:
[17Pre] A system for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal, the system comprising:	[19Pre] A computer program product comprising:	

To the extent that each preamble is limiting, Chon ‘947 (Ex-1005) discloses each preamble.

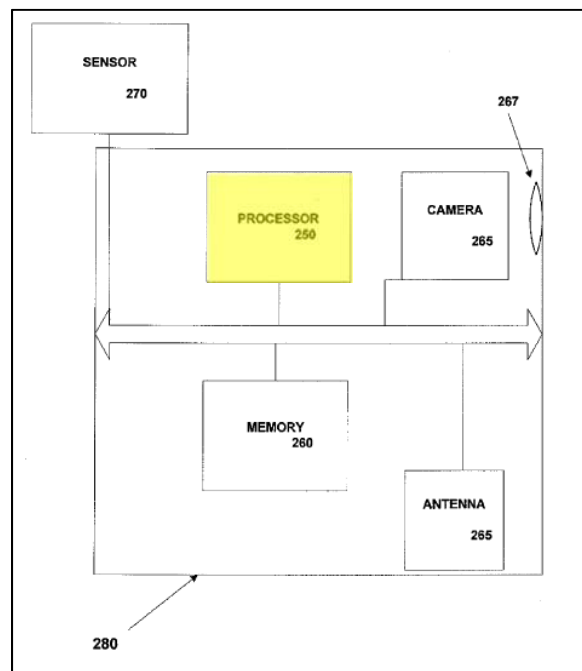
For instance, Chon ‘947 discloses a computer-implemented method/program and a system for physiological parameter monitoring using a signal such as a photoplethysmogram (PPG) signal. *See e.g.*, Ex-1005 Abstract, [0007]-[0008], [0012], [0033]-[0034]; Ex-1002 ¶64. Chon ‘947 describes the use of optical sensors or cameras in mobile devices to capture PPG signals, which can reflect physiological changes like heart rate. *See, e.g., id.* [0005]-[0006]. The PPG signal disclosed in Chon ‘947 is used to monitor physiological parameters. *See, e.g., id.* [0008], [0029], [0033], Fig. 1.

Further, Chon '947's disclosures include analyzing these PPG signals to detect motion and noise artifacts to ensure the quality of the measurements. *See, e.g.*, Chon '947 [0007], [0033]-[0067]. Therefore, Chon'947 also discloses detecting motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal. Ex-1002 ¶65.

2. “processor”

[10A] a processor configured to:	[17A] a processor configured to:
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Chon '947 disclose the use of a processor in its disclosed system. *See, e.g.*, Ex-1005 Figs. 8 (“PROCESSOR 250” shown below), [0028], [0122], [0124], [0125], [0130].



(Ex-1005, Fig. 8)

For instance, Chon ‘947 discloses a system that includes “one or more processors” as part of its mobile communication device (computer) for physiological parameter monitoring. Ex-1005 [0028]. The processors are involved in executing methods to process physiological indicator signals, with the system further incorporating computer-readable code that directs the processors to carry out specific functions. *Id.* at [0121]-[0122]; Ex-1002 ¶67.

Thus, Chon ‘947 discloses these elements.

3. “receive the signal used as the PPG signal”

[10B] receive the signal used as the PPG signal;	[17B] receive the signal used as the PPG signal;
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Chon ‘947 disclose receiving a signal used as the PPG signal. *See, e.g.*, Ex-1005 [0029], [0041]-[0045], Fig. 1. For instance, Chon ‘947 discloses that “the physiological indicator signal can be provided by a physiological monitoring sensor, for example, an external photoplethysmographic (PPG) sensor or an external electrocardiogram sensor.” *Id.* at [0034]. Further, Chon ‘947 discusses obtaining “finger-PPG signals.” *Id.* at [0043]. Chon ‘947’s system analyzes these the PPG signal to detect physiological parameters, such as heart rate, and to assess the effects of motion artifacts on the signal quality. *Id.* at [0034], [0043], [0005], [0008]; Ex-1002 ¶69.

Thus, Chon ‘947 discloses these elements.

4. “tangible computer usable media, having computer readable code embodied”

[19A] 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:
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Chon ‘947 disclose tangible computer usable media with computer readable code embodied that causes the one or more processors to perform functions. See, *e.g.*, Ex-1005 [0012] (“Embodiments and instances of computer usable media having computer readable code embodied therein, where the computer readable code causes one or more processors to implement the embodiments of the method of these teachings are also disclosed”); [0122] (“the mobile communication device includes one or more processors and one or more computer usable media, where the computer usable media has computer readable code embodied therein that causes the processor to analyze the physiological indicator signal to obtain measurements of one or more physiological parameters and to detect effects of motion artifacts in the measurements of the one or more physiological parameters.”).

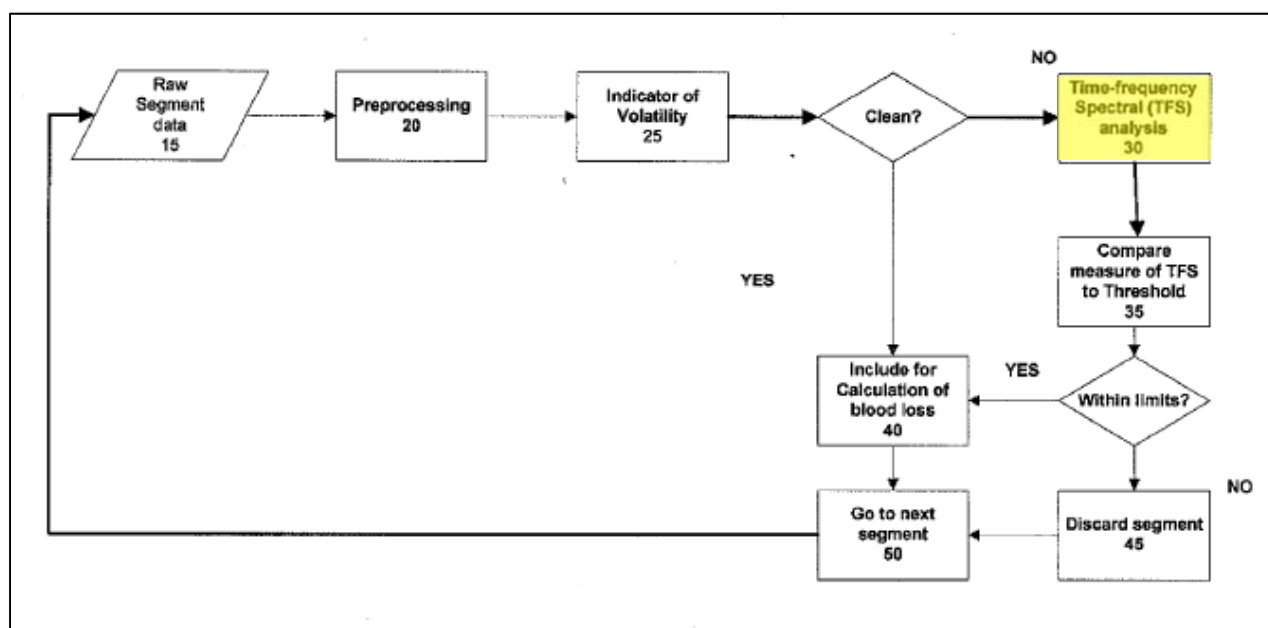
Thus, Chon ‘947 discloses this element.

5. “obtaining/obtain a time frequency spectrum ...”

[1A] obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;	[8A] obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;	[10C] obtain a time frequency spectrum of a segment of the signal used as the PPG signal;
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[17C] obtain a time frequency spectrum of a segment of the signal used as the PPG signal;	[19B] obtain a time frequency spectrum of a segment of the signal used as the PPG signal;	
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Chon ‘947 discloses the use of time-frequency spectral analysis in the context of physiological monitoring using photoplethysmogram (PPG) signals. *See, e.g.*, Ex-1005 [0045]; [0056]-[0058]; [0065] (“Once the TFS of the PPG signal is obtained via the VFCDM method”); Fig. 1b (“Time-frequency Spectral (TFS) 30”) (show below).



(Ex-1005, Fig. 1b)

Chon ‘947 also discloses how the PPG data is segmented and processed to detect artifacts and determine the quality of the measurements. *See, e.g.*, Ex-1005 at Fig. 1b (“Raw Segment data 15” show above). Chon ‘947’s method includes

performing time-frequency spectral analysis on the preprocessed PPG segments to assess their usability. *See, e.g., id.* [0037]; [0064]-[0065]; Ex-1002 ¶74.

Thus, Chon ‘947 discloses these elements.

6. “obtaining/obtain a noise quality index”

[1B] obtaining, from the time frequency spectrum, a noise quality index for the segment;	[8B] obtaining, from the time frequency spectrum, a noise quality index for the segment;	[10D] obtain, from the time frequency spectrum, a noise quality index for the segment;
[17D] obtain, from the time frequency spectrum, a noise quality index for the segment;	[19C] obtain, from the time frequency spectrum, a noise quality index for the segment;	

Chon ‘947 disclose a method using time frequency spectrum analysis, specifically in detecting motion and noise artifacts. *See, e.g.,* Ex-1005 [0037], [0056]-[0058], Fig. 1b. Chon ‘947’s method uses time-frequency spectrum analysis to assess the quality of a segment. *Id.* at [0037] (“For the measurement of an indication of blood loss, as shown in FIG. 1b, a time-frequency spectrum analysis is performed for the preprocessed segment (30, FIG. 1b) and a predetermined measure of the time-frequency spectrum analysis is compared to a predetermined measure’s threshold (35, FIG. 1b).”) As a result, under Chon ‘947 disclosed method, a noise quality index is derived from time-frequency spectral analysis. Ex-1002 ¶76.

Thus, Chon ‘947 discloses these elements.

7. “the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts”

[1C] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;	[8C] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;	[10E] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;
[17E] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;	[19D] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;	

Chon ‘947 discloses detecting and filtering out motion and noise artifacts from physiological signals such as PPG signals. *See, e.g.*, Ex-1005 [0037], [0045], [0051]-[0055], [0065]-[0067]; Fig. 1b.

For instance, Chon ‘947 discloses an approach where an obtained measure (“noise quality index”) is compared with a threshold to determine whether motion and noise artifacts are present. Ex-1005 [0037] (“If the predetermined measure is within limits determined by the predetermined measure’s threshold, the segment is included in calculations quantities of interest (40, FIG. 1b) and the method proceeds to another segment, if another segment is available (50, FIG. 1b). If the predetermined measure is not within the limits determined by the predetermined

measure’s threshold, the segment is discarded (45, FIG. 1b) and the method proceeds to another segment (50, FIG. 1b), if another segment is available.”). Ex-1002 ¶79.

Thus, Chon ‘947 discloses these elements.

8. “determining/determine a dominant frequency”

[1D] wherein obtaining a noise quality index comprises: determining a dominant frequency in the time frequency spectrum of the segment;	[8D] wherein obtaining a noise quality index comprises: determining a dominant frequency in the time frequency spectrum of the segment;	[10F] determine a dominant frequency in the time frequency spectrum of the segment;
[17F] determine a dominant frequency in the time frequency spectrum of the segment;	[19E] determine a dominant frequency in the time frequency spectrum of the segment;	

Chon ‘947 discloses a noise quality index measurement that includes determining a dominant frequency within the time frequency spectrum obtained from physiological signals such as PPG signals. *See, e.g.*, Ex-1005 [0058], [0059], [0064], [0080].

For instance, Chon ‘947 discloses the variable frequency complex demodulation method (VFCDM). *See, e.g., id.* [0064]. The disclosed VFCDM method identifies the signal’s dominant frequency by shifting each frequency to a center frequency and applying a low-pass filter. *Id.* (“At first, the fixed frequency complex demodulation technique identifies the signal’s dominant frequencies, shifts each dominant frequency to a center frequency, and applies a low-pass filter (LPF)

to each of the center frequencies. The LPF has a cutoff frequency less than that of the original center frequency and is applied to each dominant frequency.”); Ex-1002 ¶82.

Thus, Chon ‘947 discloses these elements.

9. “normalizing/normalize the time frequency spectrum”

[1E] normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;	[8E] normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;	[10G] normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;
[17G] normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;	[19F] normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;	

Chon ‘947 teaches normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency, which is part of the disclosed method for analyzing physiological signals such PPG signals. See, *e.g.*, Ex-1005 [0064], [0071], [0107]-[0108], Figs. 5, 6a and 6b.

For instance, Chon ‘947 uses the variable frequency complex demodulation method (VFCDM) technique that identifies the dominant frequencies in the signal and then applies a low-pass filter to generate band-limited signals. Ex-1005 [0064],

[0071]. “The instantaneous amplitude, phase and frequency information are obtained for each band-limited signal using the Hilbert transform and are combined to generate a time-frequency series (TFS).” *Id.* In employing the VFCDM technique, Chon ‘947 inherently discloses the use of normalizing the time frequency spectrum to the total power in a narrow band that is centered at the dominant frequency. See, e.g., Ex-1005 Fig. 5 and Fig. 6b (employing normalized frequency); Ex-1002 ¶85.

To the extent that it is found that Chon ‘947 does not disclose the “normalizing” technique, this technique was widely known and recognized in the art before the effective filing of the ‘362 Patent. Ex-1002 ¶86. Normalizing or normalization is generally a process of scaling a signal’s amplitude or magnitude to fit within a specific range, usually by dividing each sample by a reference value, making the signal comparable to other signals regardless of its initial scale. *Id.* Normalization was well known in the art to adjust the amplitude (or magnitude) of a signal’s frequency components to a common scale, usually by dividing each frequency component by a reference value like the maximum amplitude or the total power of the spectrum, allowing for easier comparison between different PPG signals from various individuals or conditions, even if their raw signal amplitudes differ significantly. *Id.*

Further, various normalizing or normalization techniques were well established and known in the art, and would have been obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. Ex-1002 ¶87.

Thus, Chon '947 discloses these elements or renders them obvious.

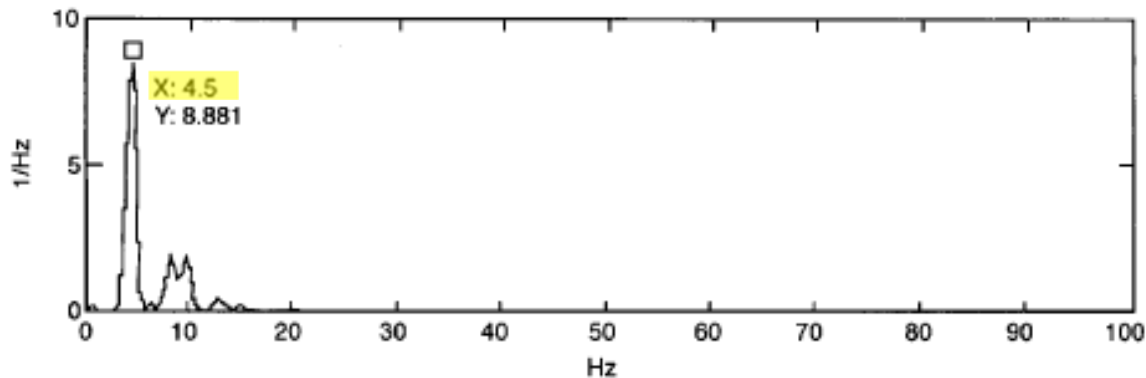
10. “determining/determine a first trace”

[1F] determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;	[8F] determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;	[10H] determine a first trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at the dominant frequency;
[17H] determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;	[19G] determine a first trace of amplitudes in a narrow band spectrum of the time frequency spectrum 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 is evident from Chon '947's method through its use of spectral analysis techniques to isolate dominant frequencies and extract relevant amplitude information within narrow frequency bands. *See, e.g.*, Ex-1005 [0058], [0065], [0071]; Ex-1002 ¶89. Chon 947's method involves analyzing the PPG signal to identify the largest instantaneous amplitude at each time point within narrow bands. *See, e.g.*, Ex-1005 [0065]; Ex-1002 ¶89. This

procedure inherently implies the need to determine a first trace of amplitudes in a narrow band spectrum. Ex-1002 ¶89.

To the extent that it is found that Chon '947 does not determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency, this technique was widely known and recognized in the art before the effective filing of the '362 Patent. *Id.* ¶90. For instance, Mollerus discloses a method for determining the first three traces of amplitudes, including the first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency. *See, e.g.*, Ex-1006 [0035]; Fig. 8 (shown below) (the first trace of amplitudes is shown to be centered at 4.5 Hz: X: 4.5); Figs. 9-12.



(Ex-1006, Fig. 8)

In particular, Mollerus discloses “measuring characteristics of the signal including power of the first three harmonics.” Ex-1006 [0035]; [0040] (“As set forth in the following description both energy ratio ER calculation using the ratio of energy under the first three harmonics of the signal are compared with the entire

spectrum and an alternative root mean square ratio RMSR was calculated using a ratio of the RMS of the first three harmonics to the entire spectrum were compared with each other”).

A POSITA would have been motivated to incorporate Mollerus’ disclosed techniques for determining the first three traces of amplitudes, including the first trace of amplitudes, into Chon ‘947’s method/system, for the reasons described in Section A above. Ex-1002 ¶92. In particular, Mollerus’ disclosed harmonics-based techniques would have been an obvious and advantageous improvement for Chon ‘947, and complement Chon ‘947’s solution to achieve high-quality physiological measurements with minimal artifacts in challenging environments. *Id.* Further, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* A POSITA would have been motivated to combine the references, and would have a reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.*

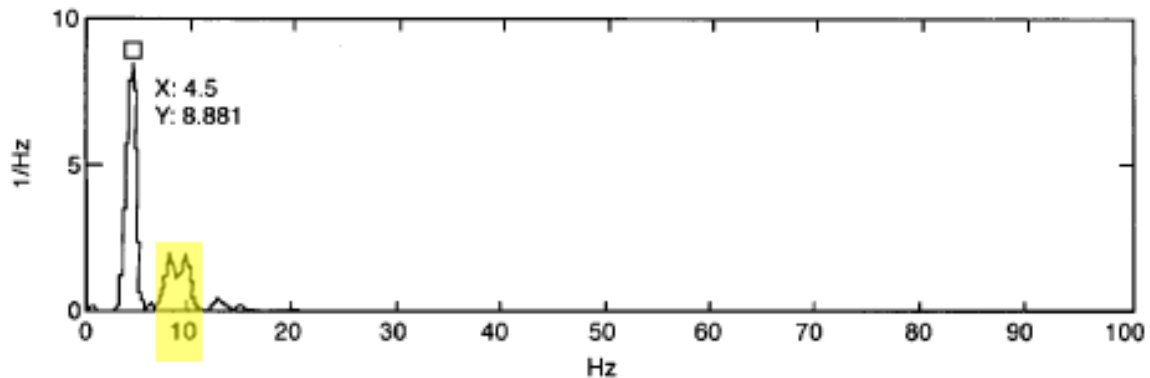
Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

11. “determining/determine a second trace”

[1G] determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;	[8G] determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;	[10I] determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;
[17I] determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;	[19H] determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice 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 is also evident from Chon ‘947’s method through its use of spectral analysis techniques to isolate dominant frequencies and extract relevant amplitude information within narrow frequency bands. *See, e.g.*, Ex-1005 [0058], [0065], [0071]; Ex-1002 ¶94. Chon 947’s method involves analyzing the PPG signal to identify the largest instantaneous amplitude at each time point within narrow bands. *See, e.g.*, Ex-1005 [0065]; Ex-1002 ¶94. This procedure inherently implies the need to determine a second trace of amplitudes in a narrow band spectrum. Ex-1002 ¶94.

To the extent that it is found that Chon '947 does not determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency, this technique was widely known and recognized in the art before the effective filing of the '362 Patent. Ex-1002 ¶95. A POSITA would have found this technique obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. *Id.* For instance, Mollerus discloses a method for determining the first three traces of amplitudes, including the second trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency. *See, e.g.,* Ex-1006 [0035]; [0041]; Fig. 8 (shown below) (the second trace of amplitudes is shown to be centered at 9 Hz); Figs. 9-12.



(Ex-1006, Fig. 8)

The second peak in Mollerus' Fig. 8 above illustrates a second trace of amplitudes centered at twice the dominant frequency, as it resides in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency. Ex-1002 ¶96. Mollerus also discloses “measuring characteristics of the signal

including power of the first three harmonics.” Ex-1006 [0035]; [0040] (“As set forth in the following description both energy ratio ER calculation using the ratio of energy under the first three harmonics of the signal are compared with the entire spectrum and an alternative root mean square ratio RMSR was calculated using a ratio of the RMS of the first three harmonics to the entire spectrum were compared with each other”).

A POSITA would have been motivated to incorporate Mollerus’ disclosed techniques for determining the first three traces of amplitudes, including the second trace of amplitudes, into Chon ‘947’s method/system, for the reasons described in Section A above. Ex-1002 ¶97. In particular, Mollerus’ disclosed harmonics-based techniques would have been an obvious and advantageous improvement for Chon ‘947, and complement Chon ‘947’s solution to achieve high-quality physiological measurements with minimal artifacts in challenging environments. *Id.* Further, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. As another example, a POSITA would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* As another example, a POSITA would have been motivated to combine the references, and would have a reasonable expectation of success in doing so, at least because the references use

known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

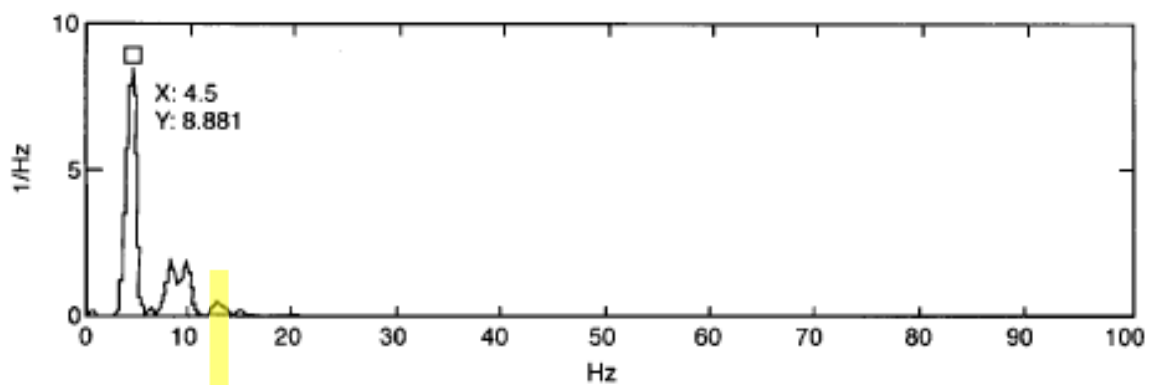
12. “determining/determine a third trace”

[1H] determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;	[8H] determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;	[10J] determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;
[17J] determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;	[19I] determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;	

Determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency is also evident from Chon ‘947’s method through its use of spectral analysis techniques to isolate dominant frequencies and extract relevant amplitude information within narrow frequency bands. *See, e.g.*, Ex-1005 [0058], [0065], [0071]; Ex-1002 ¶99. Chon 947’s method involves analyzing the PPG signal to identify the largest instantaneous

amplitude at each time point within narrow bands. *See, e.g.*, Ex-1005 [0065]. This procedure inherently discloses the need to determine a third trace of amplitudes in a narrow band spectrum. Ex-1002 ¶99.

To the extent that it is found that Chon '947 does not determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency, this technique was widely known and recognized in the art before the effective filing of the '362 Patent. Ex-1002 ¶100. A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA. *Id.* For instance, Mollerus discloses a method for determining the first three traces of amplitudes, including the third trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency. *See, e.g.*, Ex-1006 [0035], [0041], Fig. 8 (shown below) (the third trace of amplitudes is shown to be centered at 13.5 Hz); Figs. 9-12.



(Ex-1006, Fig. 8)

The third peak in Mollerus's Fig. 8 above illustrates a third trace of amplitudes centered at twice the dominant frequency, as it resides in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency. Ex-1002 ¶101. Mollerus also discloses "measuring characteristics of the signal including power of the first three harmonics." Ex-1006 [0035]; [0040] ("As set forth in the following description both energy ratio ER calculation using the ratio of energy under the first three harmonics of the signal are compared with the entire spectrum and an alternative root mean square ratio RMSR was calculated using a ratio of the RMS of the first three harmonics to the entire spectrum were compared with each other").

A POSITA would have been motivated to incorporate Mollerus' disclosed techniques for determining the first three traces of amplitudes, including the third trace of amplitudes, into Chon '947's method/system, for the reasons described in Section A above. Ex-1002 ¶102. In particular, Mollerus' disclosed harmonics-based techniques would have been an obvious and advantageous improvement for Chon '947, and complement Chon '947's solution to achieve high-quality physiological measurements with minimal artifacts in challenging environments. *Id.* Further, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings could be predictably interchanged by, for

example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* As another example, a POSITA would have been motivated to combine the references, and would have a reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

13. “subtracting/subtract and obtaining/obtain”

[11] 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 referred to as a residual noise power;	[8I] 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 referred to as a residual noise power;	[10K] 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 referred to as a residual noise power;
[17K] 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	[19J] 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	

referred to as a residual noise power;	remaining referred to as a residual noise power;	
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Chon '947 disclose a VFCDM (variable frequency complex demodulation method) for identifying and quantifying residual noise power in time-frequency spectrum data, which is used to distinguish signals of interest from motion and noise artifacts. *See, e.g.*, Ex-1005 [0065] and [00067]. Chon '947 specifically discloses the use of time-frequency spectrum analysis for the detection and management of motion artifacts and noise in physiological signals. *See, e.g.*, Ex-1005 at [0052]-[0067] Further, Chon '947's disclosed VFCDM inherently requires determining the first, second, and third traces of amplitudes, and subtracting them to obtain a total power remaining, allowing for the identification of motion and noise artifacts. Ex-1005 [0065]. Ex-1002 ¶104.

To the extent that it is found that Chon '947 does not subtract the first, second and third traces of amplitudes to obtain a total power remaining in the time frequency spectrum (referred to as a residual noise power), this technique was widely known and recognized in the art before the effective filing of the '362 Patent. Ex-1002 ¶105. A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA. *Id.* For instance, Mollerus discloses the calculation of an energy ratio (ER) and root mean square ratio (RMSR) to assess the spectral characteristics of a signal and its harmonics. *See, e.g.*, Ex-1005 [0040] ("As

set forth in the following description both energy ratio ER calculation using the ratio of energy under the first three harmonics of the signal are compared with the entire spectrum and an alternative root mean square ratio RMSR was calculated using a ratio of the RMS of the first three harmonics to the entire spectrum were compared with each other.”); *Id.*

By analyzing and comparing the amplitudes of first three harmonics to the full spectrum, Mollerus teaches subtracting them from the signal to result in residual power, which is “residual noise power” as would be understood by a POSITA. *See, e.g.,* Ex-1006 at [0035] (“In essence by transforming the signal to the frequency domain and measuring characteristics of the signal including power of the first three harmonics or Shannon entropy, the device can declare the presence of noise/artifact or supraventricular tachycardia and the absence of a ventricular arrhythmia and respond by canceling a shock therapy if a Ventricular arrhythmia is declared based upon the time domain rate threshold.”) (emphasis added); [0040] (“As set forth in the following description both energy ratio ER calculation using the ratio of energy under the first three harmonics of the signal are compared with the entire spectrum and an alternative root mean square ratio RMSR was calculated using a ratio of the RMS of the first three harmonics to the entire spectrum were compared with each other.”); Ex-1002 ¶106.

Mollerus further discloses the use of an energy ratio (ER) (or Power Ratio) calculated using the ratio of energy under the first 3 harmonics to the entire spectrum as displayed, and the use a root mean square ratio (RMSR) calculated using a ratio of the root mean square of the first3 harmonics to the entire spectrum. Ex-1006 at [0041] and Figs. 14-15; Ex-1002 ¶107. These techniques disclosed in Mollerus are useful in separating arrhythmia signals form noise and artifacts. *Id.* at [0041]; Ex-1002 ¶107.

A POSITA would have been motivated to incorporate Mollerus' disclosed techniques for obtaining a residual noise power (after subtracting the three traces of amplitudes) into Chon '947's method/system, for the reasons described in Section A above. Ex-1002 ¶108. In particular, Mollerus' disclosed harmonics-based techniques would have been an obvious and advantageous improvement for Chon '947, and complement Chon '947's solution to achieve high-quality physiological measurements with minimal artifacts in challenging environments. *Id.* Further, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* As another example, a POSITA would have been motivated to combine the references, and would have a

reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.*

Thus, Chon '947 discloses these elements or renders them obvious. In the alternative, Chon '947 in view of Mollerus renders these elements obvious.

14. “determining/determine a difference between the dominant frequency and a heart rate”

[3A] determining 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 referred to as a heart rate frequency difference; ²	[12A] 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 referred to as a heart rate frequency difference;
[8J] determining 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 referred to as a heart rate frequency difference;	[17L] 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 referred to as a heart rate frequency difference;

² Please note that I discuss the other parts of claims 3 and 12 in Section C below.

Chon '947 discloses determining a dominant frequency within a time-frequency spectrum of a photoplethysmographic (PPG) signal segment. Ex-1005 at [0064]. In this method, peak detection is employed to identify the heart rate from the PPG signal and to calculate beat-to-beat intervals. Chon '947 at [0079] (“[p]eak detection . . . to identify the [heart rate] signal”). Furthermore, Chon '947 uses time-frequency spectral analysis to assess the heart rate signal and its amplitude modulations, which directly involves identifying and extracting dominant frequencies associated with heart rate, as detailed through the variable frequency complex demodulation method (VFCDM). Chon '947 at [0064]; Ex-1002 ¶110. Therefore, Chon '947 inherently discloses comparing the dominant frequency with the heart rate signal to determine the heart rate frequency difference. Ex-1002 ¶110. Further, comparing the dominant frequency and the heart rate obtained from peak to peak intervals to determine the heart rate frequency difference was well established and known in the art. *Id.* A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA. *Id.*

To the extent that it is found that Chon '947 does not disclose these elements, Mollerus discloses them. For instance, Mollerus discloses determining a “dominant frequency” of various cardiac signals in the time frequency spectrum of a segment. *See, e.g.*, Ex-1006 [0031]; Figs. 8-12 (showing the highest peak in each time frequency spectrum).

Mollerus discloses the identification of the highest peak in the time-frequency spectrum, such as for ventricular fibrillation (VF) or baseline rhythms, and comparing these peaks to baseline data to differentiate between various cardiac events. *See, e.g., id.* [0044]; Ex-1002 ¶112. The method disclosed in Mollerus could also be used to identify a heart rate frequency difference. *Id.* Fig. 13 (shown below); [0031] (“FIG. 13 represents data in tabular form from an analysis of 31 patients. Sixty VF and 104 baseline rhythm and artifact (NONVF) events were analyzed, and energy (power) ratios and root mean square ratios were calculated from spectral transformations using both power spectral density (periodogram) and wavelet techniques. Baseline rhythm BR 400 and artifact 410 are compared to ventricular fibrillation VF 402. Energy ratios (power ratios) and root mean square ratios are compared on lines 404 and 408. Line 406 represents the dominant frequency found in BR 400, artifact 410, and VF 402.”); Ex-1002 ¶112.

Fig. 13

	VF 402	BR 400	ARTIFACT 410
404 →	ER	0.9090 (0.8180, 0.9590)	0.3370 (0.2480, 0.4100) p < 0.00001
406 →	DF (Hz)	4.5 (4.5, 5.0)	2.4 (2.0, 4.0) p < 0.00001
408 →	RMSR	0.9990 (0.9910, 1.0000)	0.2650 (0.1885, 0.3700) p < 0.00001

(Ex-1006, Fig. 13)

A POSITA would have been motivated to incorporate Mollerus' heart rate frequency difference determination technique above into Chon '947's method/system for the reasons described in Section A above. Ex-1002 ¶113. Further, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* As another example, a POSITA would have been motivated to combine the references, and would have a reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.*

Thus, Chon '947 discloses these elements or renders them obvious. In the alternative, Chon '947 in view of Mollerus renders these elements obvious.

15. “determining/determine a difference in frequency between the first trace and the second and third traces”

[1J] 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;	[10L] 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;	[19K] determine a difference in frequency between the first trace and the second and third traces; the difference in frequency referred to as projected difference;
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Chon '947 discloses a method for analyzing multiple traces of a physiological signal, specifically the first, second, and third traces of amplitude data, to identify specific characteristics of the signal that indicate the presence of arrhythmias or other medical events, including the difference in frequency referred to as a projected difference. *See, e.g.*, Chon '947 at [0065] (illustrating that the method involves extracting frequency components from time-frequency spectral analysis, specifically highlighting dominant frequencies within a physiological signal. These dominant frequencies are crucial for identifying the underlying physiological conditions, such as heart rate variability or respiratory rate); Ex-1002 ¶115. Therefore, Chon '947 inherently discloses determining a projected difference based on difference in frequency between the first trace and the second and third traces. Ex-1002 ¶115. Further, determining a projected difference based on difference in frequency between the first trace and the second and third traces was well established and known in the art, and would have been obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA. *Id.*

To the extent that it is found that Chon '947 does not disclose these elements, Mollerus discloses them. In Mollerus, one example involves spectral analysis of these traces to distinguish between clean and noisy signals, particularly in the

context of detecting ventricular arrhythmias. *See, e.g.*, Ex-1006 [0035], [0040]-[0041], FIGS. 8-12. This process includes comparing the energy or power of the first three harmonics to the overall frequency spectrum, which effectively identifies spectral fingerprints indicative of conditions such as VT (ventricular tachycardia) or VF (ventricular fibrillation). *Id.* [0007] and [0035]. Specifically, Mollerus discloses a process where the device performs frequency domain analysis by examining the power of the first three harmonics of a signal and comparing them with the entire spectrum. *Id.* [0035].

By evaluating the difference in frequency characteristics between the traces, Mollerus discloses that such analysis can be used to identify and differentiate between normal and abnormal events, effectively projecting differences in frequency that are crucial for determining whether therapeutic interventions, like shock therapy, are required. Ex-1002 ¶117. Therefore, Mollerus disclosed the claimed “projected difference” in frequency between the traces, as its method calculates the differences in energy ratios between the first three harmonics and the entire frequency spectrum, effectively projecting the differences in frequency across the traces to guide further action. *Id.*

A POSITA would have been motivated to incorporate Mollerus’ projected difference determination technique above into Chon ‘947’s method/system for the reasons described in Section A above. *Id.* ¶118. For example, a POSITA would

have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* As another example, a POSITA would have been motivated to combine the references, and would have a reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

16. “the noise quality index being a weighted sum of factors”

[1K] the noise quality index being a weighted sum of factors including the residual noise power and the projected difference;	[8K] the noise quality index being a weighted sum of factors including the residual noise power and the projected difference;	[10O] the noise quality index being a weighted sum of factors including the residual noise power and the projected difference;
[17M] the noise quality index being a weighted sum of factors including the residual noise power and the heart rate frequency difference;	[19N] wherein the noise quality index is a weighted sum of factors including the residual noise power and the projected difference;	

As discussed in Sections B.6, B.7 and B.8 above, Chon '947 discloses a noise quality index and obtaining it. Ex-1002 ¶120. Also, as discussed in Section B.13 above, Chon '947 discloses a residual noise power. *Id.* Further, as discussed in Section B.15 above, Chon '947 discloses a projected difference. *Id.* As discussed in Section B.14 above, Chon '947 discloses a heart rate frequency difference. *Id.*

Moreover, Chon '947 discloses a method using time frequency spectrum analysis for detecting motion and noise artifacts by “obtaining a value of one or more indicators of volatility for the preprocessed segment.” Ex-1005 [0037]-[0038]; *see also* [0056]-[0058], Fig. 1b. Therefore, Chon '947 inherently discloses “the noise quality index being a weighted sum of factors” that include the residual noise power and the projected difference, or that include the residual noise power and the heart rate frequency difference. Ex-1002 ¶121.

Further, the noise quality index being a weighted sum of factors was a well-established and known technique in the art, and would have been obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. *See, e.g.*, Ex-1007 [0078] (in light of the common knowledge in the art, a POSITA would recognize “weighted sum of factors” (involving multiple parameters) was well known and commonly used as it was common to express values as weighted sums of other values); Ex-1002 ¶122.

To the extent that it is found that Chon '947 does not disclose these elements, Mollerus discloses them. For instance, Mollerus discloses expressing a spectrum's signal and/or noise in various ways, such as through energy ratios and root mean square ratios. Ex-1006 [0029], [0031], [0035], [0040]-[0041]. These comparisons can determine a degree of noise within the spectrum. *Id.* A POSITA would have been motivated to use known techniques to express Chon '947's values as a weighted sum of various terms so that it could weigh and incorporate multiple factors into a single index value. A POSITA would have been motivated to include a residual noise power and a projected difference (or a heart rate frequency difference) into such a weighted sum because each of these values reflects a measure of noise within a signal, just as the features of Chon '947 discussed above reflect a measure of noise in an obtained signal. *See, e.g.,* Ex-1005 [0038]; Ex-1002 ¶123. Incorporating such measures into a weighted sum analysis would permit the POSITA to express these measures as a single value incorporating multiple component parts, and was within the knowledge of a POSITA. Ex-1002 ¶123.

Moreover, a POSITA would have been motivated to incorporate Mollerus' foregoing techniques into Chon '947's method/system for the reasons described in Section A above. Ex-1002 ¶124. For example, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings

could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* A POSITA would also have been motivated to combine the references, and would have a reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.* A POSITA would have had a reasonable expectation of success in implementing such an approach also because doing so would have amounted to nothing more than combining known methods and simple calculations to produce predictable results. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

17. “weights being selected”

[1L] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;	[8L] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;	[10P] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.
[17N] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;	[19O] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.	

Chon '947 discloses the use of volatility indicators, such as kurtosis or Shannon entropy, to detect noise or motion artifacts in physiological signals. *See, e.g.*, Ex-1005 [0030], [0038], [0048], [0049]. After preprocessing a segment of a physiological signal, one or more volatility indicators are computed, and these are then compared to predetermined thresholds to determine whether the segment is corrupted by artifacts. *See, e.g.*, Ex-1005 [0037]; Ex-1002 ¶126. The volatility indicators, such as kurtosis, quantify the probability of extreme values occurring, and a comparison to predefined thresholds helps to identify segments that fall within acceptable limits and can be considered for further analysis. *See, e.g., id.* [0037], [0053]-[0055], [0067], [0097], [0119] and Fig. 1b (Compare measure of TFS to Threshold); Ex-1002 ¶126. This approach disclosed in Chon '947 suggests that weights applied to these volatility measures are selected so that each weighted factor—such as kurtosis or Shannon entropy—represents less than a predetermined percentage of the power in an uncorrupted segment. Ex-1002 ¶126.

Further, selecting weights such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment was a well-established and known technique in the art, and would have been obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. Ex-1002 ¶127. By way of example, it was well known in the art to adjust weights in weighted sums

to achieve particular aims. *Id.* Moreover, combining different factors into a weighted sum would have involved only a simple mathematical operation of multiplying each factor by a weight and adding them together. *Id.* Such an implementation would have involved nothing more than applying existing solutions to existing technology. *Id.*

To the extent that it is found that Chon '947 does not disclose these elements, Mollerus discloses them. For instance, Mollerus discloses determining a power in "baseline data free of events." Ex-1006 [0044] ("The spectral finger print analysis for VF takes place on a short segment of acquired waveforms. Usually about two seconds worth of data. next a frequency domain analysis is performed and the energy or power present in a signature spectra are summed and compared with baseline data free of events.").

A POSITA would have been motivated to incorporate Mollerus' foregoing techniques into Chon '947's method/system for the reasons described in Section A above. Ex-1002 ¶129. For example, a POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* As another example, a POSITA would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.* A POSITA would also have been motivated to combine the references, and would

have a reasonable expectation of success in doing so, at least because the references use known variations of existing technology to solve routine and well understood problems in predictable ways. *Id.* For instance, a POSITA would have had a reasonable expectation of success in implementing such an approach also because doing so would have amounted to nothing more than combining known methods and simple calculations to produce predictable results. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

18. “apply a statistical learning method”

[1M] 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	[8M] 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	[10M] 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;
[17O] 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	[19L] 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	

Chon '947 discloses embodiments where statistical methods, such as energy ratios, Shannon entropy, and kurtosis, are applied to determine whether a signal is corrupted by noise or motion artifacts, thereby ensuring that only clean, usable data is retained for further processing. *See, e.g.*, Ex-1005 [0030], [0038], [0048], [0049]; Ex-1002 ¶131.

Chon '947 further discloses the detection of noise and motion artifacts in physiological signals, with a focus on ensuring the quality of measurements obtained from mobile devices. Ex-1005 [0007]. Chon '947 teaches that, after preprocessing physiological signal segments, a set of volatility indicators, such as kurtosis and Shannon entropy, are computed and compared to predefined thresholds to determine whether noise or motion artifacts are present. Ex-1005 [0037]; Ex-1002 ¶132. The decision of whether a signal is corrupted by artifacts or not is based on this comparison, and if the segment is free from such artifacts, it is retained for further analysis; if it is deemed corrupted, it is discarded. *Id.*; *id.* This process essentially involves applying statistical methods to assess the quality of the signal and identify whether it is corrupted by motion or noise artifacts. *Id.*; *id.* For example, the kurtosis measure helps quantify the likelihood of extreme values in the signal, which can indicate the presence of artifacts. Ex-1005 [0048]; Ex-1002 ¶132. Thus, Chon '947 discloses 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. Ex-1002 ¶132

Thus, these elements are disclosed by Chon ‘947.

19. “if motion and noise artifacts are not present, include the segment in determination of a physiological parameter”

[1N] if motion and noise artifacts are not present, including the segment in determination of a physiological parameter.	[8N] if motion and noise artifacts are not present, including the segment in determination of a physiological parameter.	[10N] if motion and noise artifacts are not present, include the segment in determination of a physiological parameter;
[17P] if motion and noise artifacts are not present, include the segment in determination of a physiological parameter.	[19M] if motion and noise artifacts are not present, include the segment in determination of a physiological parameter;	

Chon ‘947 discloses including the segment in the determination of a physiological parameter, if motion and noise artifacts are not present. Ex-1005 [0037]. Chon ‘947 aims to detect and reject motion and noise artifacts, and the corresponding signal segments are included in determination of physiological parameter when they are free of motion and noise artifacts, thereby ensuring that the data used are of acceptable quality. Ex-1005 [0037]; Ex-1002 ¶134. For instance, the signal is pre-processed to detect volatility indicators, and if these indicators meet predetermined thresholds, the segment is deemed free of artifacts and is included in

the analysis of quantities of interest. Ex-1005 [0037]. This teaching reinforces the idea that only clean, artifact-free signal segments should contribute to the determination of physiological metrics.

Thus, these elements are disclosed by Chon ‘947.

C. Dependent claims 3, 5, 6, 7, 12, 14, 15 and 16 are rendered obvious by Chon ‘947 in view of Mollerus

Claims 3, 5, 6, 7, 12, 14, 15 and 16 (dependent claims) of the ‘362 Patent are rendered obvious by Chon ‘947 (Ex-1005) in view of Mollerus (Ex-1006) under AIA 35 U.S.C. § 103, as supported by the declaration of Dr. George E. Yanulis. Ex-1002.

1. Claim 3’s Preamble / Claim 12’s Preamble

[3Pre] The computer implemented method of claim 1 further comprising:	[12Pre] The system of claim 10 wherein the processor is further configured to
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To the extent that each preamble is limiting, Chon ‘947 (Ex-1005) discloses each preamble.

For instance, Chon ‘947 discloses a computer-implemented method and a system for physiological parameter monitoring using a signal such as a photoplethysmogram (PPG) signal. *See e.g.*, Ex-1005 Abstract, [0007]-[0008], [0012], [0033]-[0034]; Ex-1002 ¶138.

2. “wherein the noise quality index also comprises the heart rate frequency difference”³

[3B] 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.	[12B] 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.
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As discussed in Sections B.6, B.7 and B.8 above, Chon ‘947 discloses a noise quality index and obtaining it. Ex-1002 ¶139. Also, as discussed in Section B.13 above, Chon ‘947 discloses a residual noise power. *Id.* Further, as discussed in Section B.15 above, Chon ‘947 discloses a projected difference. *Id.* As discussed in Section B.14 above, Chon ‘947 discloses a heart rate frequency difference. *Id.*

Moreover, Chon ‘947 discloses a method using time frequency spectrum analysis for detecting motion and noise artifacts by “obtaining a value of one or more indicators of volatility for the preprocessed segment.” Ex-1005 [0037]-[0038]; *see also* [0056]-[0058], Fig. 1b. Therefore, Chon ‘947 inherently discloses “the noise quality index being a weighted sum of factors” that include the residual noise power, the projected difference and the heart rate frequency difference. Ex-1002 ¶140.

Further, the noise quality index being a weighted sum of factors was a well-established and known technique in the art, and would have been obvious in light of

³ Please note that I have already discussed Elements [3A] and [12A] in Section B above.

Chon '947's disclosure and preexisting knowledge of a POSITA. *See, e.g.*, Ex-1007 [0078] (in light of the common knowledge in the art, a POSITA would recognize "weighted sum of factors" (involving multiple parameters) was well known and commonly used as it was common to express values as weighted sums of other values); Ex-1002 ¶141.

To the extent that it is found that Chon '947 does not disclose these elements, Mollerus discloses them. For instance, Mollerus teaches analyzing the time-frequency spectrum of cardiac signals and identifying the dominant frequency, which could include the heart rate frequency difference, as seen in ventricular fibrillation or baseline rhythm identification. Ex-1006 [0031]. Mollerus also teaches comparing frequency peaks to baseline data, enabling the determination of the heart rate frequency difference. *Id.* [0044]. Further, Mollerus discloses expressing a spectrum's signal and/or noise in various ways, such as through energy ratios and root mean square ratios. Ex-1006 [0029], [0031], [0035], [0040]-[0041]; Ex-1002 ¶142. These comparisons can determine a degree of noise within the spectrum. Ex-1002 ¶142. A POSITA would have been motivated to use known techniques to express Chon '947's values as a weighted sum of various terms so that it could weigh and incorporate multiple factors into a single index value. *Id.* A POSITA would have been motivated to include a residual noise power, a projected difference, and heart rate frequency difference into such a weighted sum because each of these

values reflects a measure of noise within a signal, just as the features of Chon '947 discussed above reflect a measure of noise in an obtained signal. *See, e.g.*, Ex-1005 [0031], [0038], [0044]; Ex-1002 ¶142. Incorporating such measures into a weighted sum analysis would permit the POSITA to express these measures as a single value incorporating multiple component parts, and was within the knowledge of a POSITA. Ex-1002 ¶142.

A POSITA would have been motivated to incorporate Mollerus' foregoing teachings into Chon '947's method/system for the reasons described in Section A above. Ex-1002 ¶143. For example, Chon '947 discloses the use of time-frequency spectral analysis on PPG signals, where peak detection identifies heart rate frequency and beat-to-beat intervals, and the dominant frequency is compared to the heart rate signal to indirectly assess the heart rate frequency difference. *See, e.g.*, Ex-1005 [0079]; Ex-1002 ¶143. When considered together, Chon '947 and Mollerus would have suggested a straightforward and successful integration of the heart rate frequency difference technique into a noise quality index. A POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. Ex-1002 ¶143. A POSITA would have had a reasonable expectation of success in implementing such an approach also because doing so would have amounted to nothing more than combining known methods and simple calculations to produce predictable results. *Id.* As another example, a POSITA

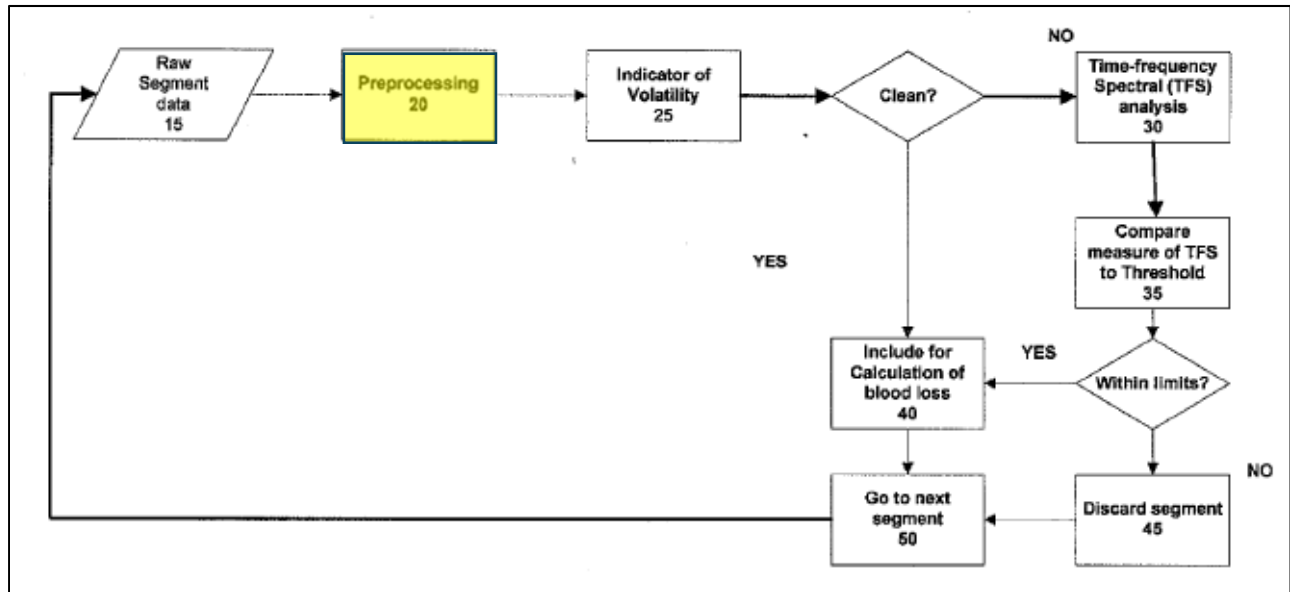
would have found that the teachings could be predictably interchanged by, for example, simple substitution, at least because of the predictability of the art and the known interchangeability of the various elements. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

3. preprocessing the signal used as the PPG signal

[5] The computer implemented method of claim 1 wherein the signal used as the PPG signal is preprocessed before obtaining the time frequency spectrum.	[14] The system of claim 10 wherein the processor is further configured to preprocess the signal used as the PPG signal before obtaining the time frequency spectrum.
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Chon ‘947 discloses a method/system for detecting motion artifacts in PPG signals, which includes preprocessing the signal used as the PPG signal before obtaining the time frequency spectrum. *See, e.g.*, Ex-1005 [0037], [0044]-[0045], [0047] (“Following the preprocessing of each PPG data segment, our approach for the detection of artifacts involves the computation of the following two parameters”), [0067]; Fig. 1a; Fig. 1b (“Preprocessing 20”) (shown below).



(Ex-1005, Fig. 1b)

As another example, Chon ‘947 discloses that a segment of a signal from PPG is “preprocessed (filtered),” and that subsequent analysis, including time-frequency spectrum analysis, is conducted on the preprocessed data. Ex-1005 [0067]; Ex-1002 ¶146. Chon ‘947 further discloses details the use of filtering, polynomial detrending, and zero-mean processing as part of the preprocessing to eliminate unwanted noise and trends from the PPG signal. Ex-1005 [0045]; Ex-1002 ¶146. After preprocessing, the signal is analyzed to determine whether it meets predetermined criteria, ensuring that only relevant, high-quality data is included in the final analysis.

Thus, Chon ‘947 discloses these elements.

4. Preprocessing by filtering with a bandpass filter of predetermined band width

[6] The computer implemented method of claim 5 wherein the signal used as the PPG signal is preprocessed by filtering with a bandpass filter of predetermined band width.	[15] The system of claim 14 wherein the processor is configured to preprocess the signal used as the PPG signal by filtering with a bandpass filter of predetermined bandwidth.
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Chon '947 also discloses preprocessing the signal used as the PPG signal by filtering with a bandpass filter of predetermined band width. *See, e.g.*, Ex-1005, [0045] (“The PPG data were partitioned into 60s segments and shifted every 10s for the entire data. Each 60s PPG segment was subjected to finite impulse response (FIR) band pass filter of order 64 with cut-off frequencies of 0.1 Hz and 10 Hz”).

Further, filtering with a bandpass filter of predetermined band width for preprocessing a signal used as a PPG signal was a well-established and known technique in the art, and would have been obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. Ex-1002 ¶149.

To the extent that it is found that Chon '947 does not disclose these elements, Mollerus discloses them. For instance, Mollerus discloses the use of a bandpass filter in its method, where the “band pass and gain characteristics of the sense amplifier are ‘tuned’ to discriminate this relatively large (voltage) physiologic signal (EMG) from myopotentials and other electrical noise signals” Ex-1006 [0003]. Mollerus's process of tuning the bandpass filter effectively filters out unwanted

noise, focusing on the desired physiological signal. Ex-1002 ¶150. Additionally, Mollerus teaches that the “typical passband for VF is 3.5 to 7.5 hertz although variation can be expected in the optimal range,” thereby disclosing a bandpass filter with a predetermined band width. Ex-1006 [0044]; Ex-1002 ¶150.

A POSITA would have been motivated to incorporate Mollerus’s foregoing teachings into Chon ‘947’s method/system for the reasons described in Section A above. Ex-1002 ¶151. When considered together, Chon ‘947 and Mollerus would have suggested a straightforward and successful integration of bandpass filter with a predetermined band width for preprocessing a signal used as a PPG signal into Chon ‘947’s method/system. *Id.* A POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* A POSITA would have had a reasonable expectation of success in implementing such an approach also because doing so would have amounted to nothing more than combining known methods and simple calculations to produce predictable results. *Id.*

Thus, Chon ‘947 discloses these elements or renders them obvious. In the alternative, Chon ‘947 in view of Mollerus renders these elements obvious.

5. “using variable frequency complex demodulation”

[7] The computer implemented method of claim 1 wherein the time frequency spectrum is obtained using variable frequency complex demodulation.	[16] The system of claim 10 wherein the processor is configured to obtain the time frequency spectrum using variable frequency complex demodulation.
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Chon ‘947 discloses a computer implemented method/system wherein the time frequency spectrum is obtained using a “variable frequency complex demodulation,” which is also known by its abbreviation “VFCD” or “VFCDM” (“variable frequency complex demodulation method”). *See, e.g.*, Ex-1005 [0058] (“A time-frequency method known as the variable frequency complex demodulation method (VFCDM) to be described hereafter is used because it has been shown to provide one of the highest time-frequency resolutions.”), [0059], [0064]-[0065], [0071], [0093], and [0097]; Ex-1002 ¶153.

Thus, Chon ‘947 discloses these elements.

XIII. GROUND 2: CLAIMS 2, 4, 9, 11, 13, 18 AND 20 ARE RENDERED OBVIOUS BY CHON ‘947 IN VIEW OF MOLLERUS AND FURTHER IN VIEW OF SIMON

Dependent claims 2, 4, 9, 11, 13, 18 and 20 (dependent claims) of the ‘362 Patent are rendered obvious by Chon ‘947 (Ex-1005) in view of Mollerus (Ex-1006) and further in view of Simon (Ex-1009) under AIA 35 U.S.C. § 103, as supported by the declaration of Dr. George E. Yanulis. Ex-1002.

1. “statistical learning method is a Support Vector Machine (SVM)”

[2] The computer implemented method of claim 1 wherein the statistical learning method is a Support Vector Machine (SVM).	[4] The computer implemented method of claim 3 wherein the statistical learning method is a Support Vector Machine (SVM).	[9] The computer implemented method of claim 8 wherein the statistical learning method is a Support Vector Machine (SVM).
[11] The system of claim 10 wherein the statistical learning method is a Support Vector Machine (SVM).	[13] The system of claim 12 wherein the statistical learning method is a Support Vector Machine (SVM).	[18] The system of claim 17 wherein the statistical learning method is a Support Vector Machine (SVM).
[20] The computer program product of claim 19 wherein the statistical learning method is a Support Vector Machine (SVM).		

To a POSITA, a support vector machine or SVM was a well-known learning algorithm for analyzing data for classification and regression analysis. Ex-1002 ¶156. Further, the ‘362 Patent itself admits that Support Vector Machine (SVM) was widely known in the art. Ex-1001 9:36-45 (“SVM was applied to build a decision boundary to classify the MNA segment from the clean PPG data. SVM is widely used for classification and regression analysis due to its accuracy and robustness to noise.”).

To a POSITA, incorporating a support vector machine (SVM) as the statistical learning method in Chon ‘947 would have been obvious and straightforward in light of the ‘362 Patent’s specification and preexisting knowledge of a POSITA. Ex-1002 ¶157. Such an implementation would have involved nothing more than applying an existing solution to existing technology. *Id.*

Moreover, Simon discloses the use of a Support Vector Machine (SVM). Simon discloses the use of a support vector machine (SVM), which is an “algorithmic approach to the problem of classification within the larger context of supervised learning.” Ex-1009 69:22-23. Simon discloses that “a training set of physiological data will have been acquired that includes whether or not the patient is experiencing some type of acute attack” and a “classification of the patient’s state is whether or not an attack is in progress, and the data used to make the classification consist of the remaining acquired physiological data, evaluated at Δ time units prior to the time at which the attack data are acquired.” *Id.* 69:27-34. In Simon, the support vector machine (SVM) is trained to forecast the imminence of an attack, and after the training, support vector machine (SVM) is implemented as part of the controller to sound an alarm. *Id.* 69:34-37.

A POSITA would have been motivated to combine the teachings of Chon ‘947 with Simon’s teachings, and would have had a reasonable expectation of success in doing so because each relates to physiological measurement and monitoring. *See,*

e.g., Ex-1005 [0007]-[0010]; Ex-1009 15:8-48; 35:29-57; 69:18-50; Fig. 15; Ex-1002 ¶159. A POSITA would have been motivated to incorporate Simon's foregoing teachings into Chon '947's method/system. *Id.* When considered together, Chon '947 and Mollerus would have suggested a straightforward and successful integration of a Support Vector Machine (SVM) into Chon '947's method/system/program. *Id.* A POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. *Id.* A POSITA would have had a reasonable expectation of success in implementing such an approach also because doing so would have amounted to nothing more than combining known methods and simple calculations to produce predictable results. *Id.*

Further, a POSITA would have been motivated to combine the teachings of Chon '947 and Mollerus due to a shared focus on accurate physiological measurements and alerts of health conditions. Ex-1002 ¶160. A POSITA would recognize that combining Simon's SVM technique with the motion and noise artifact detection disclosed in Chon '947 could improve the accuracy of its monitoring methods/systems. *Id.* By combining Chon '947 with the SVM teachings of Simon would enhance the overall performance of Chon '947's methods/systems/programs, ensuring more accurate readings of vital signs. *Id.*

Thus, Chon ‘947 renders these elements obvious. In the alternative, Chon ‘947 combined with Simon renders these elements obvious.

XIV. DISCRETIONARY DENIAL WOULD BE INAPPROPRIATE

A. No Discretionary Denial Under *Fintiv*

The Fintiv factors strongly favor institution. In particular, Petitioner is offering a *Sotera* stipulation (see factor 4, below).

Factor 1: Potential Stay

No motion to stay has been filed in the Related Litigation, and the Board should not infer the outcome of such a motion even if filed. *See Sand Revolution II LLC v. Continental Intermodal Group - Trucking LLC*, IPR2019-01393, Paper 24 at 7 (PTAB June 16, 2020) (informative). Thus, this factor is neutral.

Factor 2: Proximity of Trial to FWD

The Related Litigation was filed in the Eastern District of Texas on July 31, 2023, and is currently set for trial before District Judge Robert W. Schroeder, III on February 17, 2026. Ex-1012. However, “a court’s general ability to set a fast paced schedule is not particularly relevant ... where, like here, the forum itself has not historically resolved cases so quickly.” *In re Apple Inc.*, 979 F.3d 1332, 1344 (Fed. Cir. 2020). Here, Judge Schroeder currently has seven other patent trials scheduled to begin on February 17, 2026. Ex-1013. Although the currently-scheduled trial date is about six months before a final written decision here (around

August 2026), the Board has granted institution in similar circumstances. *See, e.g., NetNut Ltd. v. Bright Data Ltd.*, IPR2021-01492, Paper 12 (PTAB March 21, 2022) (granting institution when trial was scheduled six months before the final written decision deadline).

Further, Judge Schroeder currently has 135 active patent cases and a median time-to-trial of 50.6 months—pushing the realistic trial date here to likely a much later date than February 17, 2026. Ex-1014.

This factor favors institution or is, at worst, neutral.

Factor 3: Investment in Parallel Proceeding

The Related Litigation is in its early stages, with major activities including claim construction term exchanges not even having started as of the filing of this Petition. Ex-1012. The court has not issued any substantive orders, Ex-1015, and the parties have not yet invested substantial time in the litigation. Thus, this factor favors institution.

Factor 4: Overlapping Issues

There is no overlap of prior-art issues with the Related Litigation. Moreover, Petitioner offers the following stipulation: If the Board institutes review, Petitioner will not pursue in the Related Litigation the grounds raised or that reasonably could have been raised in this Petition with respect to the claims for which review is instituted. *See Sotera Wireless, Inc. v. Masimo Corp.*,

IPR2020-01019, Paper 12 at 16-19 (Dec. 1, 2020) (precedential as to §II.A).

Petitioner also filed a stipulation to that effect in the Related Litigation. Ex-1011.

The Director's June 2022 memorandum states that, when a petitioner so stipulates, "the PTAB will not discretionarily deny institution" due to parallel litigation.

Memo, supra n.1, at 7.

Thus, this factor favors institution.

Factor 5: The Parties

Petitioner is a defendant in the Related Litigation. Accordingly, this factor favors institution.

Factor 6: Other Circumstances

The Petition's merits are particularly strong as reflected above, which favors institution. Moreover, denying institution would negate Congress's intent in providing a 1-year period to file petitions and would encourage forum shopping.

Accordingly, the *Fintiv* factors strongly weigh against denial.

B. No Discretionary Denial Under 35 U.S.C. § 325(d)

The prior art and arguments for the invalidity grounds in this Petition were not presented during the prosecution of the '362 Patent. Ex-1002 ¶¶35-36. Thus, Petitioner is currently not aware of any indication that the Office was previously presented with "the same or substantially the same prior art or arguments." 35 U.S.C. §325(d). The first prong of *Advanced Bionics* is therefore unmet, and the

Board “need not address the second part.” *JUUL Labs, Inc. v. NJOY, LLC*, IPR2024-00160, Paper 10 at 13 (PTAB May 24, 2024).

Thus, the Board should not deny institution under section 325(d).

XV. CONCLUSION

Accordingly, Petitioner respectfully requests that the Board institute IPR and cancel claims 1-20 of U.S. Pat. No. 10,653,362.

Respectfully submitted,

/Jack Shaw/

Jack Shaw (Reg. No. 72,262)

CLAIM LISTING

Claim 1

[1Pre] A computer implemented method for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:

[1A] obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;

[1B] obtaining, from the time frequency spectrum, a noise quality index for the segment;

[1C] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

[1D] wherein obtaining a noise quality index comprises: determining a dominant frequency in the time frequency spectrum of the segment;

[1E] normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

[1F] determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

[1G] determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

[1H] determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

[1I] 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 referred to as a residual noise power;

[1J] 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;

[1K] the noise quality index being a weighted sum of factors including the residual noise power and the projected difference;

[1L] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

[1M] 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

[1N] if motion and noise artifacts are not present, including the segment in determination of a physiological parameter.

Claim 2

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

Claim 3

[3Pre] The computer implemented method of claim 1 further comprising:

[3A] determining 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 referred to as a heart rate frequency difference;

[3B] 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.

Claim 4

4. The computer implemented method of claim 3 wherein the statistical learning method is a Support Vector Machine (SVM).

Claim 5

5. The computer implemented method of claim 1 wherein the signal used as the PPG signal is preprocessed before obtaining the time frequency spectrum.

Claim 6

6. The computer implemented method of claim 5 wherein the signal used as the PPG signal is preprocessed by filtering with a bandpass filter of predetermined band width.

Claim 7

7. The computer implemented method of claim 1 wherein the time frequency spectrum is obtained using variable frequency complex demodulation.

Claim 8

[8Pre] A computer implemented method for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the computer implemented method comprising:

[8A] obtaining a time frequency spectrum of a segment of the signal used as the PPG signal;

[8B] obtaining, from the time frequency spectrum, a noise quality index for the segment;

[8C] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

[8D] wherein obtaining a noise quality index comprises: determining a dominant frequency in the time frequency spectrum of the segment;

[8E] normalizing the time frequency spectrum to a total power in a narrow band centered at the dominant frequency;

[8F] determining a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

[8G] determining a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

[8H] determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

[8I] 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 referred to as a residual noise power;

[8J] determining 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 referred to as a heart rate frequency difference;

[8K] the noise quality index being a weighted sum of factors including the residual noise power and the projected difference;

[8L] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

[8M] 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

[8N] if motion and noise artifacts are not present, including the segment in determination of a physiological parameter.

Claim 9

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

Claim 10

[10Pre] A system for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal, the system comprising:

[10A] a processor configured to:

[10B] receive the signal used as the PPG signal;

[10C] obtain a time frequency spectrum of a segment of the signal used as the PPG signal;

[10D] obtain, from the time frequency spectrum, a noise quality index for the segment;

[10E] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

[10F] determine a dominant frequency in the time frequency spectrum of the segment;

[10G] normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

[10H] determine a first trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

[10I] determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

[10J] determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

[10K] 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 referred to as a residual noise power;

[10L] 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;

[10M] 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,

[10N] if motion and noise artifacts are not present, include the segment in determination of a physiological parameter;

[10O] the noise quality index being a weighted sum of factors including the residual noise power and the projected difference;

[10P] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

Claim 11

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

Claim 12

[12Pre] The system of claim 10 wherein the processor is further configured to

[12A] 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 referred to as a heart rate frequency difference;

[12B] 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.

Claim 13

[13] The system of claim 12 wherein the statistical learning method is a Support Vector Machine (SVM).

Claim 14

[14] The system of claim 10 wherein the processor is further configured to preprocess the signal used as the PPG signal before obtaining the time frequency spectrum.

Claim 15

[15] The system of claim 14 wherein the processor is configured to preprocess the signal used as the PPG signal by filtering with a bandpass filter of predetermined bandwidth.

Claim 16

[16] The system of claim 10 wherein the processor is configured to obtain the time frequency spectrum using variable frequency complex demodulation.

Claim 17

[17Pre] A system for detection of motion and noise artifacts in a signal used as a Photoplethysmogram (PPG) signal, the system comprising:

[17A] a processor configured to:

[17B] receive the signal used as the PPG signal;

[17C] obtain a time frequency spectrum of a segment of the signal used as the PPG signal;

[17D] obtain, from the time frequency spectrum, a noise quality index for the segment;

[17E] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

[17F] determine a dominant frequency in the time frequency spectrum of the segment;

[17G] normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

[17H] determine a first trace of amplitudes in the narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

[17I] determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

[17J] determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

[17K] 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 referred to as a residual noise power;

[17L] 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 referred to as a heart rate frequency difference;

[17M] the noise quality index being a weighted sum of factors including the residual noise power and the heart rate frequency difference;

[17N] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment;

[17O] 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

[17P] if motion and noise artifacts are not present, include the segment in determination of a physiological parameter.

Claim 18

[18] The system of claim 17 wherein the statistical learning method is a Support Vector Machine (SVM).

Claim 19

[19Pre] A computer program product comprising:

[19A] 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:

[19B] obtain a time frequency spectrum of a segment of a signal used as a PPG signal;

[19C] obtain, from the time frequency spectrum, a noise quality index for the segment;

[19D] the noise quality index being used to determine whether the segment is corrupted by motion and noise artifacts;

[19E] determine a dominant frequency in the time frequency spectrum of the segment;

[19F] normalize the time frequency spectrum to the total power in a narrow band centered at the dominant frequency;

[19G] determine a first trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at the dominant frequency;

[19H] determine a second trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at twice the dominant frequency;

[19I] determine a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;

[19J] 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 referred to as a residual noise power;

[19K] 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;

[19L] 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

[19M] if motion and noise artifacts are not present, include the segment in determination of a physiological parameter;

[19N] wherein the noise quality index is a weighted sum of factors including the residual noise power and the projected difference;

[19O] weights being selected such that each weighted factor represents less than a predetermined percentage of power in an uncorrupted segment.

Claim 20

[20] The computer program product of claim 19 wherein the statistical learning method is a Support Vector Machine (SVM).

**CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME
LIMITATION, TYPEFACE REQUIREMENTS, AND
TYPE-STYLE REQUIREMENTS**

Pursuant to 37 C.F.R. §42.24(d), I certify that the foregoing Petition complies with the type-volume limitation of 37 C.F.R. §42.24 and contains 13,935 words based on the word count indicated by the word-processing system used to prepare the paper, excluding the parts exempted by 37 C.F.R. §42.24(a). Further, the foregoing Petition complies with the general format requirements of 37 C.F.R. §42.6(a) and has been prepared using Microsoft Word in 14-point Times New Roman.

Dated: February 3, 2025

Respectfully submitted,

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CERTIFICATE OF SERVICE (37 C.F.R. §42.6(e)(1))

The undersigned hereby certifies that the above document was served on February 3, 2025, by filing this document through the Patent Trial and Appeal Board P-TACTS System, as well as delivering a copy via express mail upon the following attorneys of record for the Patent Owner.

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