

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

**DECLARATION OF DR. GEORGE E. YANULIS
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,653,362**

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EXHIBIT LIST¹

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 Declaration, 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 Declaration refer to original page, column, paragraph, or line numbers.

I, George E. Yanulis, declare as follows:

I. INTRODUCTION

A. Engagement

1. I have been retained by counsel for Petitioner Zepp Health Corporation (“Zepp” or “Petitioner”) as an expert witness for the above-captioned *inter partes* review (IPR) proceeding. I have been asked to consider the validity of Claims 1-20 of U.S. Patent No. 10,653,362 (the “‘362 Patent” or the “Patent”) in view of prior art, obviousness considerations, and the understanding of a person of ordinary skill in the art at the time of the invention as it relates to the ‘362 Patent. I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto.

B. Compensation

2. For my time working on this matter, I am being compensated at my standard hourly consulting rate. I do not have any personal or financial stake or interest in the outcome of the present proceeding, and the compensation is not dependent on the outcome of this IPR and in no way affects the substance of my statements in this Declaration. I do not have any expectation or promise of additional business with the Petitioner in exchange for the positions explained herein. My analysis here is based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those cited herein.

C. Qualifications and Experience

3. I have over 35 years of experience in biomedical engineering and designing medical devices. Particularly, I have direct experience within the field of medical monitors that measure physiological parameters and provide statistical analyses relating to the parameters. My experience is related specifically to electrocardiograms, cardiac echo imaging, and cardiac pressure/volume analysis, which are closely related to pulse oximetry, oxygen saturation, and pulse rate. Through my experience, I have learned how to integrate medical monitoring technology into the medical profession.

4. I received my Bachelor of Arts in Pre-medicine degree in 1977 from Syracuse University, which included a minor in Chemistry. Originally, I planned to go to medical school, but I found that my interests aligned more closely to medical devices than practicing medicine. So, I pivoted to biomedical engineering, and I received a Master's degree in Biomedical Engineering from the University of Virginia in 1981. I closely studied medical devices while in graduate school at Virginia, including using preamplifiers to record evoked cortical signals to better understand the etiology of Epilepsy.

5. For approximately the next two decades, my professional experience included serving in the armed services as a 1st Lieutenant and Clinical Engineer for the Air Force (stationed at the Malcolm Grow Medical Center, Andrews Air Force

Base), working as a Logistics Engineer for RCA, and conducting research within the education industry (at Syracuse, Alabama-Birmingham, Drexel, and the University of Pennsylvania). I was a Clinical Engineering Consultant involved with the Y2k Program at the Hospitals of the University of Pennsylvania from 1999-2000. I continued as a research assistant at the University of Pittsburgh, but in 2002, I decided to pursue a doctorate. Even though I was leaving, my mentor at Pitt awarded me a Master of Science in Bioengineering for my research work rather than leave without a degree. I studied medical devices at Pitt, but also implantable devices, such as using elastomeric polymers to design artificial diaphragm muscles.

6. Still continuing my education, I received a Doctor of Engineering (D.Eng.) from Cleveland State University in 2008. For my Doctorate, I focused on Applied Biomedical Engineering. It was during my Doctorate that I developed a specialty in cardiovascular medical devices and treatments, with a focus on treating atrial fibrillation. At Cleveland State, we studied electrical stimulation (i.e., coupled pacing applied near the end of the T-wave, which represents the repolarization of the ventricles in electrocardiography to prevent rapid ventricle conduction during atrial fibrillation (AF)), and whether the benefits of coupled pacing could be used during persistent AF.

7. Since obtaining my D.Eng., I have taught the next generation of bright minds. From 2009-2013, I was an adjunct professor at the College of Staten Island

teaching Engineering and Physics, and since 2015, I have been an Adjunct Professor at Temple University teaching Bioengineering.

8. In my career, I have had multiple research projects focusing on clinical assessment of medical devices and monitoring systems. For example, I had experience in the research and development of a heart rate monitoring system based on my earlier bench studies conducted related to my Doctoral research at the Cleveland Clinic (2005-2008) and now with Medical Device Consulting, LLC (2016-Present). I have consulted on heart bypass systems (2017-2018), and I served as a consultant on several cardiac pacemaker device related cases which involved monitoring heart rate, pulse rate, ECG. I was involved in reviewing critical monitoring systems as both a member and peer reviewer of submitted manuscripts of the association for the advancement of Medical Instrumentation (2012-present). At Cleveland State, I was involved in the research and design of critical care monitoring systems used for heart failure therapy patients both from 2005-2008, as part of my D.Eng. and since 2014, as part of my research and the development of a heart monitoring system. Further still, from 2015-2017, I was also involved in mentoring Temple bio-engineering students in the design of critical care monitoring systems for both cardiac systems courses and biomedical instrumentation design courses. Finally, I was involved in reviewing clinical care monitoring system as a clinical engineer with the USAF from 1987-1989.

9. I also have continued to study cardiovascular devices and other medical devices as a consultant. Particularly, I collaborated with Data Science Corporation to design a device that used a time elapsed interval between two consecutive R-waves of the QRS heart signal (R-R interval) to potentially use on heart failure therapy patients. I have assisted with 250 Cardiac Pacemaker Device Implants on dogs to develop pacing algorithms for heart failure therapy patients. Also, I have performed over 500 ECG signal detection sessions and cardiac pressure-volume analysis on dogs. Further still, I have intensely studied Heart Failure Cardiac Pressure/Flow Sensor Monitoring Systems.

10. Lastly, I have written six peer-reviewed articles in this area and other areas of medical device development. My publications from the last 10 years are listed in my CV where my CV is submitted as Ex-1003 to the Petition.

11. Thus, my background demonstrates an expertise and strong understanding of medical devices and how they can improve the health of patients.

D. Information Considered and Relied Upon

12. In preparation for this declaration, I have considered the materials discussed in this declaration, including, for example, the '362 Patent, the references cited by the '362 Patent, the prosecution history of the '362 Patent (including the references cited therein), various background articles and materials referenced in this declaration, and the prior art references identified in this declaration. In addition, my

opinions are further based on my education, training, experience, and knowledge in the relevant field.

II. PERSON OF ORDINARY SKILL IN THE ART

13. 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.

14. The proposed level of skill for the POSITA would not change if a different priority of the invention date is found.

III. LEGAL STANDARDS

15. I am not an attorney, and I have not been asked to offer any legal opinions. In preparing and expressing my opinions in this Declaration, I have applied

the legal standards described below, which were explained to me by counsel for Petitioner.

A. Claim Interpretation

16. I have been informed and understand that in an IPR proceeding, claims are to be interpreted according to the *Phillips* claim construction standard. I understand that under this standard, the meaning of claim terms is considered from the viewpoint of a POSITA at the time of the alleged invention. I have been informed and understand that claim construction is a matter of law and that the final claim constructions for this proceeding will be determined by the Patent Trial and Appeal Board (“PTAB”).

17. I have been informed that claim terms are generally given their ordinary and customary meaning as understood by one of ordinary skill in the art in light of the specification and the prosecution history pertaining to the patent. I understand, however, that claim terms are generally not limited by the embodiments described in the specification.

18. I understand that in addition to the claims, specification, and prosecution history, other evidence may be considered to ascertain the meaning of claim terms, including textbooks, encyclopedias, articles, and dictionaries. I have been informed that this other evidence is often less significant and less reliable than the claims, specification, and prosecution history. In interpreting the meaning of the

claim language, I understand that a person of ordinary skill in the art may also consider “extrinsic” evidence, including expert testimony, inventor testimony, dictionaries, technical treatises, other patents, and scholarly publications. I understand extrinsic evidence is sometimes considered to interpret a claim in light of the understanding of those skilled in the art at the time of the invention. I understand that extrinsic evidence may not be relied on if it contradicts or varies the meaning of claim language provided by the intrinsic evidence, particularly if the applicant has explicitly defined a term in the intrinsic record.

B. Obviousness (35 U.S.C. § 103 (AIA))

19. I understand that a patent claim is obvious if the differences between the patented subject matter and the prior art are such that the subject matter as a whole would have been obvious, at the time the invention was made, to a person having ordinary skill in the art. Relevant considerations for an obviousness determination include the level of ordinary skill in the art; the scope and content of the prior art; differences between the prior art and the claims at issue; and the so-called objective secondary factors of nonobviousness.

20. I understand that a claim can be found to be obvious if all the claimed elements were known in the prior art and that one skilled in the art could have combined the elements as claimed by known methods with no change in their

respective functions, and the combination would have yielded nothing more than predictable results to one of ordinary skill in the art.

21. I understand that hindsight must not be used when comparing the prior art to the invention for obviousness. Thus, a conclusion of obviousness must be firmly based on knowledge and skill of a POSITA at the time the invention was made without the use of post-filing knowledge.

22. I understand that in order for a claimed invention to be considered obvious, there must be some motivation to combine the cited references as proposed.

23. I understand that obviousness may also be shown by demonstrating that it would have been obvious to modify what is taught in a single piece of prior art to create the patented invention. Obviousness may be shown by showing that it would have been obvious to combine the teachings of more than one item of prior art, with a reasonable expectation of success in doing so. In determining whether a piece of prior art could have been combined with other prior art or with other information within the knowledge of one of ordinary skill in the art, the following are examples of approaches and rationales that may be considered:

- (a) Combining prior art elements according to known methods to yield predictable results;
- (b) Simple substitution of one known element for another to obtain predictable results;

- (c) Use of a known technique to improve similar devices (methods, or products) in the same way;
- (d) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- (e) Applying a technique or approach that would have been “obvious to try” (choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success);
- (f) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; or
- (g) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

24. I further understand that certain factors may support or rebut the obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of invention, unexpected results of the invention, any long-felt but unresolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the

alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I understand that there must be a nexus—a connection—between any such secondary considerations and the alleged invention (i.e., the features that are alleged to make the claim patentable).

IV. SUMMARY OF OPINIONS

25. It is my opinion that claims 1-20 of the ‘362 Patent are invalid under 35 U.S.C. § 103 (AIA) on the following grounds:

- **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).
- **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).

V. OVERVIEW OF THE ‘362 PATENT (EX-1001)

A. Brief Summary of the Challenged Patent

26. 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. Ex-0001, 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. Ex-0001, 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. Ex-0001, 4:44-48. The '362 Patent uses a processor that applies these methods for real-time artifact detection. 'Ex-0001, 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. 'Ex-0001, 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. Ex-0001, 12:30-35.

27. In summary, the '362 Patent describes an MNA detection algorithm that extracts time-varying spectral features to distinguish between clean and corrupted components. This use of MNA reduces false readings of heart rate and oxygen

saturation, particularly in, e.g., wearable devices for ambulatory applications, such as wrist-worn sensors used during intense physical activities. The MNA detection method leverages time-domain features, including heart rate variability, amplitude, and waveform morphology, in combination with an SVM classifier.

28. Further, the '362 patent discloses using an MNA detection method that uses dynamic characteristics of the corrupted PPG derived via the VFCDM (variable frequency complex demodulation method) to generate a high-resolution time-frequency spectrum of the PPG signal, enabling detection of MNA by calculating a Noise Quality Index. '362 Patent at 6:30-45. The VFDCM is a time-frequency analysis technique commonly used in physiological signal processing. It is designed to estimate the time-frequency spectrum (TFS) of a signal, offering high time and frequency resolution while preserving the accurate amplitude distribution of the original signal. The SpaMA algorithm, as outlined in the '362 Patent, consists of five stages: (1) calculation of the time-varying power spectral density (PSD), (2) spectral filtering, (3) motion artifact detection, (4) heart rate (HR) reconstruction, and (5) signal reconstruction. The process purportedly involves real-time, window-segmented calculation of the power spectral density for both PPG and accelerometer signals. Each PSD estimate is then scaled by the equivalent noise bandwidth of the window to improve accuracy.

B. Summary of Claims

29. The '362 Patent includes 20 claims, five of which are independent claims: 1, 8, 10, 17 and 19. The rest of the claims are dependent claims.

30. Claim 1, which is representative of claims 10 and 19, recites a computer-implemented method for monitoring physiological parameters using a Photoplethysmogram (PPG) signal. It outlines steps for obtaining a time-frequency spectrum of the PPG signal, calculating a noise quality index based on the spectral analysis, and using the index to determine if the signal segment is corrupted by motion or noise artifacts. If the segment is free of motion or noise artifacts, it is used in the calculation of a physiological parameter.

31. Claim 8, which is representative of claim 17, recites a computer implemented method for monitoring physiological parameters using a Photoplethysmogram (PPG) signal. It includes a computer that receives the PPG signal, analyzes its time-frequency spectrum to compute a noise quality index, and determines if the segment is corrupted by motion or noise artifacts. If no motion or noise artifacts are detected, the system uses the clean segment to compute the physiological parameter, with the noise quality index being based on factors like residual noise power and projected frequency differences.

C. Prosecution History of the ‘362 Patent

32. 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.

33. 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.

34. 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.

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

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

D. Priority Date

37. I understand that the earliest possible priority date that the patent owner may claim for the '362 Patent is based on provisional application No. 62/109,183's filing date of January 29, 2015. I do not concede that any claim of the Patent is entitled to that priority date. I further understand that all 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.

E. Claim Construction

38. I do not believe that any claim term of the Patent requires explicit construction to resolve the issues presented in this Petition. I apply the plain and ordinary meaning to each claim term, as that plain and ordinary meaning would have been understood by a POSITA.

39. I reserve the right to offer opinions on any claim constructions proposed in this proceeding or to offer opinions on constructions in the district court litigation.

VI. TECHNOLOGY BACKGROUND

40. The '362 Patent relates to a computer-implemented method for detecting motion and noise artifacts (MNA) in Photoplethysmogram (PPG) signals, which are commonly used by pulse oximeters (PO) to monitor physiological parameters like heart rate and oxygen saturation. This technology is rooted in time-frequency (TF) analysis methods, which were already well-known and routine to a POSITA prior to the filing date of the '362 Patent. The patent discloses the use of techniques such as Short Time Fourier Transform (STFT) and Variable Frequency Complex Demodulation (VFCDM), both of which were extensively applied in the field for mitigating motion artifacts. These methods work by analyzing the time-frequency spectrum of PPG signals to compute a noise quality index (NQI), which quantifies the presence of artifacts. Ex-1001, Background.

41. Further, based on the state of the art and common knowledge in the field, a POSITA would recognize that apparatuses incorporating biomedical sensors and reconstruction units, such as those used in pulse oximeters, were already well established in the field. For instance, the '362 Patent acknowledges that pulse oximeter signals included not only data on blood oxygen saturation and heart rate

but also other vital physiological information, as noted by Edgar (Ex-1007) and Chon 2009 (Ex-1008), both of which are prior art.

42. Edgar describes a computer-implemented method for monitoring physiological parameters, specifically using a Photoplethysmogram (PPG) signal, to identify and mitigate the impact of motion and noise artifacts. Edgar (Ex-1007) Abstract. Edgar's method involves obtaining a time-frequency spectrum of a segment of the PPG signal and calculating a noise quality index to assess whether the segment is corrupted by artifacts. *Id.* [0044].

43. Chon 2009 describes a method for estimating respiratory rate from photoplethysmography (PPG) signals using variable frequency complex demodulation (VFCDM). Ex-1008 at 2054; Ex-1010, Ex-1002 ¶49 (showing that Chon 2009 was published on April 14, 2009). By analyzing the time-frequency spectrum of the PPG signal, VFCDM identifies frequency modulation (FM) related to respiration. *Id.* The method is compared with other techniques like continuous wavelet transform (CWT) and autoregressive (AR) models, showing better accuracy, consistency, and efficiency, particularly for higher respiratory rates. The approach includes signal preprocessing, such as filtering and downsampling, to accurately extract the respiratory rate while minimizing noise and artifacts. *Id.*

44. Further, the use of time-frequency analysis techniques, such as Short Time Fourier Transform (STFT) and Variable Frequency Complex Demodulation

(VFCDM), for mitigating motion artifacts in Photoplethysmogram (PPG) signals was routine and well known prior to the earliest possible priority date of the '362 Patent, as confirmed by prior art such as Edgar (Ex-1007).

VII. BRIEF DESCRIPTION OF THE APPLIED PRIOR ART

45. In my opinion, and as explained in further detail below, 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 prior to the filing of the '362 Patent. Numerous prior art references teach computer implemented methods for physiological parameter monitoring using a signal used as a Photoplethysmogram (PPG) signal. The techniques that the Patent's claims used to obtaining a time frequency spectrum, and a noise quality index used to determine whether the segment is corrupted by motion and noise artifacts were well known in the art. The techniques such as weighted sum of factors including the residual noise power and the projected difference to determine the noise quality index were commonly known to a POSITA. The techniques of "determining a dominant frequency," "normalizing the time frequency spectrum," and "applying a statistical learning method" are not new neither.

A. Chon '947 (Ex-1005)

46. 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.

47. 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.*

48. 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].

B. Mollerus (Ex-1006)

49. 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.

50. 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].

51. 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].

C. Simon (Ex-1009)

52. 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.

53. 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.

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

54. In my opinion, 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).

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

55. In my opinion, 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]. 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.

56. Further, 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. Both references aim to address challenges in obtaining reliable physiological data in dynamic environments—Chon ‘947 through the use of mobile communication devices and optical video monitoring for physiological parameter detection, and Mollerus through improving artifact detection in implanted medical devices like pacemakers and implantable cardioverter defibrillators. Chon ‘947 (Ex-1005) at [Abstract]; Mollerus (Ex-1006) at [0002].

57. Chon ‘947 describes a method for detecting motion artifacts in physiological monitoring using mobile devices, which rely on sensors such as optical cameras and LEDs to capture vital signs. As disclosed in Chon ‘947, motion and noise artifacts can severely affect the quality of measurements, leading to inaccurate physiological data. Ex-1005 [0007].

58. Chon ‘947 also provides algorithms for identifying and discarding corrupted segments caused by motion and noise artifacts to ensure that measurements are valid and reliable. *Id.* [0010]. Chon ‘947’s focus on motion artifact detection aligns closely with the approach taken by Mollerus, where the detection of noise and other artifacts is crucial for distinguishing between normal heart rhythms and unwanted noise in implantable medical devices.

59. A POSITA would recognize that combining Mollerus’s techniques with the motion and noise artifact detection disclosed in Chon ‘947 could improve the ability to assess physiological parameters for mobile monitoring methods/systems. 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.

60. 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. A POSITA would have recognized that the combination of Chon ‘947’s sensor-based physiological monitoring with Mollerus’s noise reduction techniques would have been an obvious

and advantageous improvement, as Mollerus would be complementary to Chon '947: obtaining higher-quality physiological measurements with minimal motion and noise artifacts in challenging environments.

61. 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. Both Chon '947 and Mollerus discuss methods for improving the signal quality in real-time applications. By combining Chon '947 preprocessing approach with Mollerus's signal analysis techniques, even more efficient and reliable method and system could be achieved for motion and noise artifact reduction in physiological monitoring devices. This would enhance the overall performance of such devices, ensuring more accurate readings of vital signs.

62. Since Chon '947 discloses the use of systems and methods that enable physiological monitoring with a mobile communication device and that allow detection of motion artifacts so that the results reported are of acceptable quality are disclosed, and since Mollerus discloses the use of a spectral fingerprint technique as disclosed allows an implantable cardioverter-defibrillator (ICD) to eliminate unnecessary shocks to the heart, it would have been obvious for a POSITA to combine the teachings of Chon '947 with Mollerus's teachings.

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

63. In my opinion, 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.

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:	

64. 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]. Chon ‘947 describes the use of optical sensors or cameras in mobile devices to capture PPG signals, which can

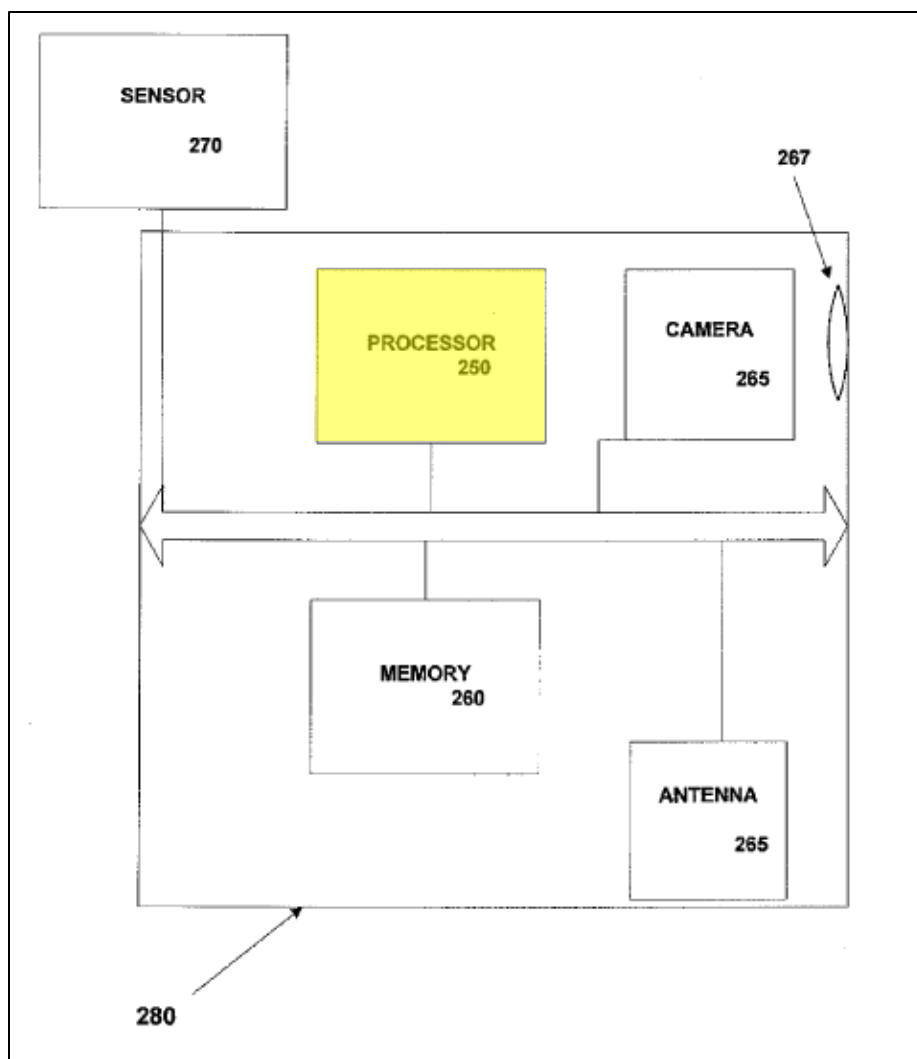
reflect physiological changes like heart rate. *See, e.g., id.* [0005]-[0006]. The PPG signal disclosed in Chon '947 is used to monitor physiological parameters. *See, e.g., id.* [0008], [0029], [0033], Fig. 1.

65. 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.

2. “processor”

[10A] a processor configured to:	[17A] a processor configured to:
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66. 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)

67. 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].

68. 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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69. 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].

70. 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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71. 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

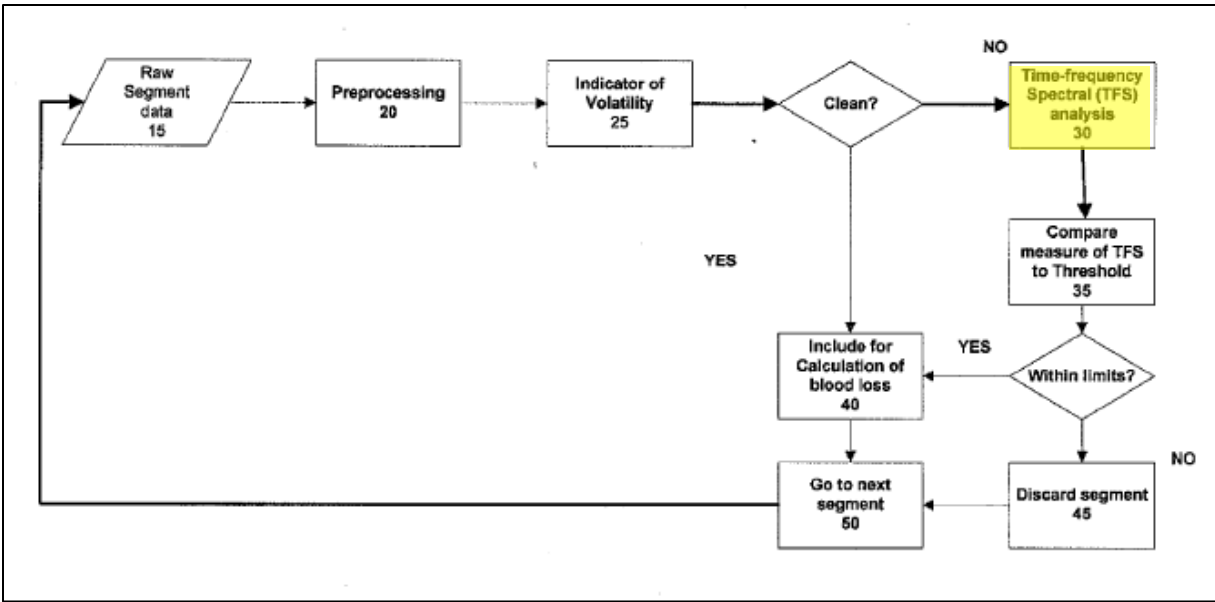
having computer readable code embodied therein, where the computer readable code causes one or more processors to implement the embodiments of the method of these teachings are also disclosed”); [0122] (“the mobile communication device includes one or more processors and one or more computer usable media, 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.”).

72. 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;
[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;	

73. 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)

74. 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].

75. 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;	

76. 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.

77. 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;	

78. 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.

79. 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.”).

80. 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;	

81. 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].

82. 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.”).

83. 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	[19F] normalize the time frequency spectrum to the total power in a narrow	

band centered at the dominant frequency;	band centered at the dominant frequency;	
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84. 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.

85. 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).

86. 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. 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. 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.

87. 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.

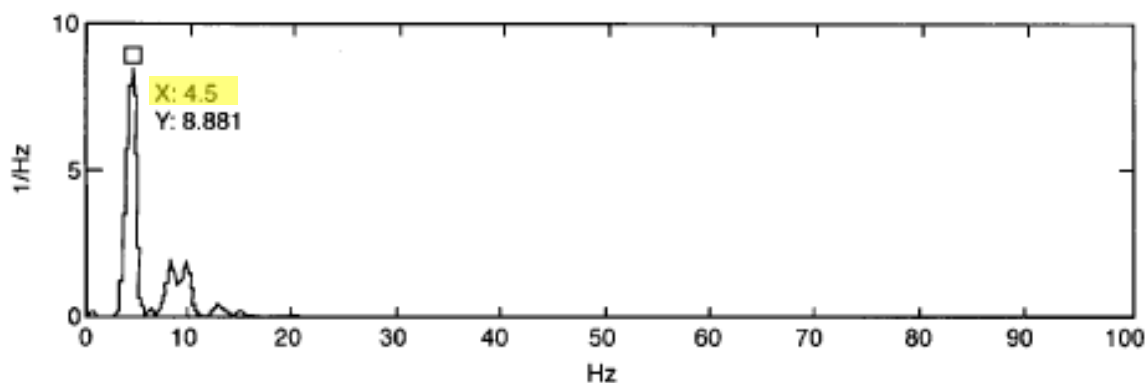
88. Thus, Chon '947 discloses these elements or renders them obvious.

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;	

89. 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]. 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 implies the need to determine a first trace of amplitudes in a narrow band spectrum.

90. 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. 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)

91. 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”).

92. In my opinion, 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. 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.

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. 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.

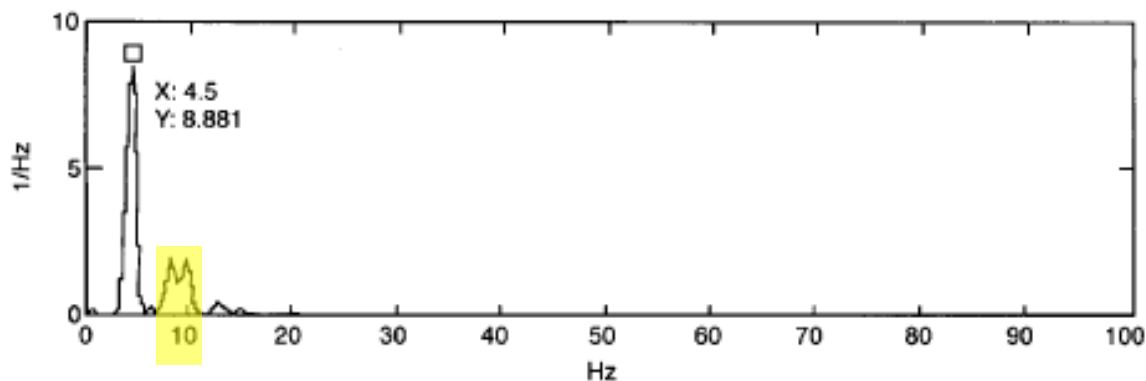
93. Thus, Chon '947 discloses these elements or renders them obvious. In the alternative, Chon '947 in view of Mollerus renders these elements obvious.

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;	

94. 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]. 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 implies the need to determine a second trace of amplitudes in a narrow band spectrum.

95. 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. A POSITA would have found this technique obvious in light of Chon '947's disclosure and preexisting knowledge of a POSITA. 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)

96. 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. 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”).

97. In my opinion, 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. 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. 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. 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.

98. 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”

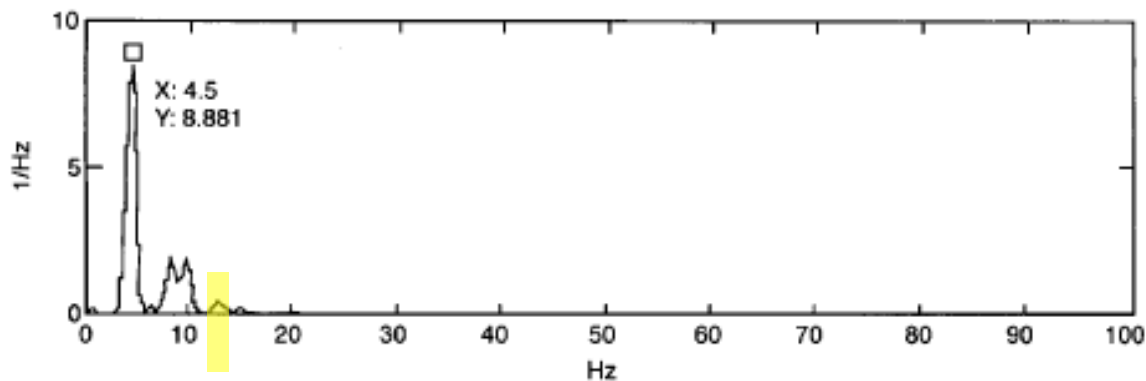
[1H] determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;	[8H] determining a third trace of amplitudes in a narrow band spectrum of the time frequency spectrum centered at three times the dominant frequency;	[10J]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

spectrum centered at three times the dominant frequency;	spectrum centered at three times the dominant frequency;	
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99. 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]. 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.

100. 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. A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA. 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)

101. 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. 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").

102. In my opinion, 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. 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. 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. 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.

103. 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,	[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	[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
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said total power remaining referred to as a residual noise power;	total power remaining referred to as a residual noise power;	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 referred to as a residual noise power;	[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;	

104. 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]. Moreover, 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].

105. 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. A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA. 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.”).

106. 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.”).

107. 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. These techniques disclosed in Mollerus are useful in separating arrhythmia signals form noise and artifacts. *Id.* at [0041].

108. In my opinion, 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. 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.

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. 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.

109. 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	[17L] determine a difference between the dominant frequency and a heart rate

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

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;	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;
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110. 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]. Therefore, Chon '947 inherently discloses comparing the dominant frequency with the heart rate signal to determine the heart rate frequency difference. 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. A POSITA would also have been motivated to combine the teachings of Chon '947 with the knowledge of a POSITA.

111. 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).

112. 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]. 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.”).

Fig. 13

	VF	BR	ARTIFACT
ER	0.9090 (0.8180, 0.9590)	0.3370 (0.2480, 0.4100) p < 0.00001	0.2650 (0.1885, 0.3700) p < 0.00001
DF (Hz)	4.5 (4.5, 5.0)	2.4 (2.0, 4.0) p < 0.00001	3.0 (2.5, 6.3) p = 0.014
RMSR	0.9990 (0.9910, 1.0000)	0.5310 (0.3450, 0.6030) p < 0.00001	0.4900 (0.2915, 0.6310) p < 0.00001

(Ex-1006, Fig. 13)

113. In my opinion, 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. 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. 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.

114. 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 a projected difference;
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115. 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). Therefore, Chon ‘947 inherently discloses determining a projected difference based on difference in frequency between the first trace and the second and third traces. 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.

116. 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].

117. 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. 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.

118. In my opinion, 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. 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. 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. 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.

119. 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;	

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

121. 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.

122. 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).

123. 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]. 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.

124. In my opinion, 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. 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. 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. 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. Also, 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.

125. 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.	

126. 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., id.* [0037]. 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). 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.

127. 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. By way of example, it was well known in the art to adjust weights in weighted sums to achieve particular aims. 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. It is my opinion that such an implementation would have involved nothing more than applying existing solutions to existing technology.

128. 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.”).

129. In my opinion, 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. 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. 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. 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. For example, 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.

130. 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	[8M] applying a statistical learning method, using the	[10M] apply a statistical learning method, using
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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	noise quality index, to determine whether the segment is corrupted by motion and noise artifacts or not corrupted by motion and noise artifacts; and	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	

131. 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].

132. 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]. 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.* 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.* For example, the kurtosis measure helps quantify the likelihood of extreme values in the signal, which can indicate the presence of artifacts. *Id.* [0048]. 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.

133. 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;	

134. 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]. 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.

135. 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

136. In my opinion, 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.

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

138. 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].

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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139. As discussed in Sections B.6, B.7 and B.8 above, Chon '947 discloses a noise quality index and obtaining it. Also, as discussed in Section B.13 above, Chon '947 discloses a residual noise power. Further, as discussed in Section B.15

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

above, Chon '947 discloses a projected difference. As discussed in Section B.14 above, Chon '947 discloses a heart rate frequency difference.

140. 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.

141. 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).

142. 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]. These comparisons can determine a degree of noise within the spectrum. 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, 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]. 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.

143. In my opinion, 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. 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]. 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. 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. 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.

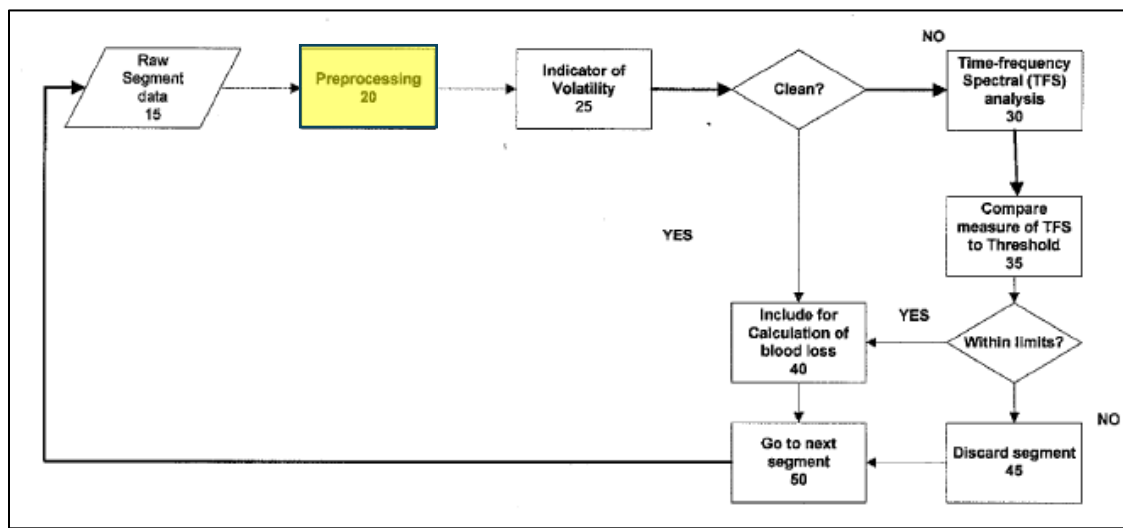
144. Thus, Chon '947 discloses these elements or renders them obvious. In the alternative, Chon '947 in view of Mollerus renders these elements obvious.

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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145. 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)

146. 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]. 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. *Id.* [0045]. 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.

147. 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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148. 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”).

149. 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.

150. 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. 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].

151. In my opinion, 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. 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. A POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. 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.

152. 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	[16] The system of claim 10 wherein the processor is configured to obtain
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spectrum is obtained using variable frequency complex demodulation.	the time frequency spectrum using variable frequency complex demodulation.
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153. 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].

154. Thus, Chon ‘947 discloses these elements.

IX. 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

155. In my opinion, 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.

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

[2] The computer implemented method	[4] The computer implemented method	[9] The computer implemented method of
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of claim 1 wherein the statistical learning method is a Support Vector Machine (SVM).	of claim 3 wherein the statistical learning method is a Support Vector Machine (SVM).	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).		

156. As well-established in the art, a support vector machine or SVM was a well-known learning algorithm for analyzing data for classification and regression analysis. 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.”).

157. Therefore, 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. It is my opinion that such an implementation would have involved nothing more than applying an existing solution to existing technology.

158. 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.

159. In my opinion, 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. A POSITA would have been motivated to incorporate Simon’s foregoing teachings into Chon ‘947’s method/system. 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. A POSITA would have found the combination obvious to try, due at least to the similarity of the technical teachings of the art. 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.

160. 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. 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. 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.

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

X. SECONDARY CONSIDERATIONS

162. I am not aware of any evidence of secondary considerations of non-obviousness of the claims 1-20 of the '362 Patent. However, I reserve the right to rebut if the Patent Owner identifies any.

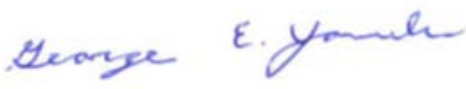
XI. CONCLUSION

163. For the reasons set forth above, it is my opinion that claims 1-20 of the '362 Patent are unpatentable in view of the prior art.

164. In signing this Declaration, I understand that the Declaration will be filed as evidence in a contested case before the PTAB.

165. I declare, under the penalty of perjury, that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true.

Dated: February 3, 2025

By: 
George E. Yanulis