

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

K/S HIMPP
Petitioner

v.

BRAGI GmbH
Patent Owner

Case IPR2023-00901

**DECLARATION OF BRIAN W. ANTHONY, PH.D.
U.S. PATENT NO. 10,635,385
CHALLENGING CLAIMS 1-16**

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I, Brian W. Anthony, declare as follows:

I. INTRODUCTION

1. My name is Dr. Brian W. Anthony. I am an Associate Principal Research Scientist at the Institute of Medical Engineering & Science at Massachusetts Institute of Technology (MIT). I am also a Principal Research Scientist at MIT's Mechanical Engineering department, Director of the Master of Engineering in Advanced Manufacturing and Design Program at MIT, Director of Health Technology at the MIT Center for Clinical and Translational Research, a Co-Director of the Medical Electronic Device Realization Center of the Institute of Medical Engineering & Science, and Associate Director of MIT.nano.

2. I have been retained as an expert in this proceeding by counsel for K/S HIMPP. I have been asked for my expert conclusions regarding the validity of claims 1-16 of U.S. Patent No. 10,635,385 (the "'385 Patent") (Ex. 1001-USP385). For the reasons set forth below, it is my conclusion that claims 1-16 of the '385 patent are invalid.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

3. My qualifications are stated more fully in my curriculum vitae, which is attached as Exhibit A. Below is a summary of my education, work experience, and other qualifications.

4. I earned my B.S. in Engineering (1994) from Carnegie Mellon University. I earned my M.S. (1998) and Ph.D. (2006) in Engineering from MIT. My research focused on high-performance computation, signal processing, and electro-mechanical system design.

5. In 1997, I co-founded Xcitex Inc., a company that specialized in video-acquisition and motion-analysis software. I served as the Chief Technology Officer and directed and managed product development until 2006.

6. I joined MIT in 2006 and was the Director of the Master of Engineering in Advance Manufacturing and Design Program for over ten years. The degree program covers four main components: Manufacturing Physics, Manufacturing Systems, Product Design, and Business Fundamentals. Many of the courses, projects, and papers my students undertake involve technologies relevant to the patent at issue, for example, software applications for interfacing with electronic devices.

7. In 2011, I co-founded MIT's Medical Electronic Device Realization Center ("MEDRC") and currently serve as co-director. The MEDRC aims to create and deploy revolutionary medical technologies by collaborating with clinicians, the microelectronics, and medical devices industries. We combine expertise in computation; communications; optical, electrical, and ultrasound sensing technologies; and consumer electronics. We focus on the usability and productivity

of medical devices using, for example, image and signal processing combined with intelligent computer systems to enhance practitioners' diagnostic intuition. Our research portfolio includes low power integrated circuits and systems, big data, micro electro-mechanical systems, bioelectronics, sensors, and microfluidics. Specific areas of innovation include wearable, non-invasive and minimally invasive optical biosensor devices, medical imaging, laboratory instrumentation, and the data communication from these devices and instruments to healthcare providers and caregivers. My experience with these devices is directly applicable to the technology in the patent at issue.

8. I am currently the Co-Director of the Device Realization Lab at the Medical Electronic Device Realization Center at the Institute of Medical Engineering & Science at MIT. The Device Realization Lab designs instruments and techniques to sense and control physical systems. Medical devices and manufacturing inspection systems are a particular focus. We develop and combine electromechanical systems, complex algorithms, and computation systems to create instruments and measurement solutions for problems that are otherwise intractable.

9. The research of the Device Realization Lab focuses on product development interests cross the boundaries of computer vision, acoustic and ultrasonic imaging, large-scale computation and simulation, optimization, metrology, autonomous systems, and robotics. We use computation, and computer

science, as methodology for attacking complex instrumentation problems. My work combines mathematical modeling, simulation, optimization, and experimental observations, to develop instruments and measurement solutions.

10. As set forth in my CV (Exhibit A), my record of professional service includes recognitions from several professional organizations in my field of expertise. I am a named inventor on 10 issued U.S. patents. I have published approximately 100 papers and have received a number of best paper and distinguished paper awards.

11. I am being compensated for my time at my ordinary hourly rate of \$500. My compensation is not dependent on the outcome of these proceedings or the content of my opinions. To the best of my knowledge, I have no financial interest in either party or in the outcome of this proceeding.

III. MATERIALS CONSIDERED

12. In preparing this declaration, I have reviewed the claims, specification, and file history of the '385 patent. I understand that the '385 patent issued on April 28, 2020, from U.S. Application No. 15/350/020, filed on November 12, 2016. The '385 patent states that it claims priority to U.S. Provisional Application No. 62/255,309, filed on November 13, 2015.

13. I have also reviewed and understand the references and exhibits cited in this Declaration, including the following:

Exhibit	Description
1001	U.S. Patent No. 10,635,385 (“385 patent”)
1003	U.S. Patent No. 9,781,514 (“Hensen-Patent”)
1004	YouTube.com, <i>September 2015 – FreeWavz Demo</i> [https://www.youtube.com/watch?v=zHNZ7p5GnH4] (“Hensen-Video”)
1005	<i>User Manual: LG Heart Rate Earphones</i> (“LG-Manual”)
1006	U.S. Patent Appl. No. 2014/0189600 (“Lee”)
1007	Kickstarter.com, November 22 Progress Report (“Hensen-Kickstarter”) [https://web.archive.org/web/20150924011438/https://www.kickstarter.com/projects/freewavz/freewavzsmart-earphones-with-built-in-fitness-mon/posts/1057132]
1008	U.S. Patent No. 9,161,131 (“Hensen-Parent”)
1009	U.S. Provisional Application No. 62/061,497 (“Hensen-Provisional”)
1010	Screenshots from Hensen-Video
1011	File History for U.S. Patent No. 10,635,385 (“385 FH”)
1012	Twitter.com – Posts by FreeWavz [https://twitter.com/Freewavz]
1013	Twitter.com - October 2014 Snapshot of Posts by FreeWavz [https://web.archive.org/web/20141026181307/twitter.com/Freewavz]
1014	Kickstarter.com, <i>Pulse Oximetry Success + FreeWavz Testing + Factory Preparation</i> [https://www.kickstarter.com/projects/freewavz/freewavz-smart-earphones-with-built-in-fitness-mon/posts/1349732]
1015	FreeWavz.com – Home Page [https://web.archive.org/web/20151004055203/http://www.freewavz.com/]

Exhibit	Description
1016	FreeWavz.com – News Page [https://web.archive.org/web/20151006111823/http://www.freewavz.com/news/]
1017	FreeWavz.com – About Page [https://web.archive.org/web/20151008013534/http://freewavz.com/about/]
1018	Olympics.com – History of Triathlon [https://olympics.com/en/sports/triathlon/#discipline-history-of]
1019	LG.com – FR74 Product Page [https://web.archive.org/web/20150507002217/http://www.lg.com/us/support-mobile/lg-FR74#]
1020	FCC.gov – FR74 FCC Application [https://apps.fcc.gov/oetcf/eas/reports/ViewExhibitReport.cfm?mode=Exhibits&RequestTimeout=500&calledFromFrame=N&application_id=5sSYi3UFjhWeKosDZgHTHQ%3D%3D&fcc_id=BEJ9QK-DMFR74]
1021	FCC.gov – FR74 User Manual (Attachment to FCC Application) [https://apps.fcc.gov/eas/GetApplicationAttachment.html?id=2186303]
1022	Kickstarter.com – FreeWavz Creator Bio [https://web.archive.org/web/20150912193027/https://www.kickstarter.com/projects/freewavz/freewavz-smart-earphones-with-built-in-fitness-mon/creator_bio]
1023	Internet Archive Declaration of Nathaniel E Frank-White
1024	U.S. Patent No. 9,392,946
1025	U.S. Patent No. 8,818,476

IV. LEGAL PRINCIPLES

14. I am not an attorney. For the purposes of this declaration, I have been informed by HIMPP’s counsel about certain aspects of the law that are relevant to

my analysis, as stated in the following paragraphs. I have applied these legal principles in arriving at my conclusions expressed in this declaration.

15. I have been informed and understand that a patent claim is invalid if it would have been obvious to a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention recited in the claims. This means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the claim would have been obvious to a POSITA at the time of the alleged invention.

16. I have been informed and understand that a determination of whether a claim would have been obvious should be based upon several factors, including, among others: (1) the level of ordinary skill in the art at the time of the alleged invention; (2) the scope and content of the prior art; (3) the differences, if any, that existed between the claimed invention and the prior art; and (4) any objective considerations of nonobviousness.

17. I have been informed and understand that when determining any differences between the invention covered by the patent claims and the prior art, one should not look at the individual differences between the patent claims and the prior art in isolation, but rather consider the claimed invention as a whole and determine whether or not it would have been obvious in light of all of the prior art.

18. I have been informed and understand that a single reference can render a patent claim obvious if any differences between that reference and the claims would have been obvious to a POSITA. Alternatively, the teachings of two or more references may be combined in the same way as disclosed in the claims. I have been informed and understand that when deciding whether to combine the various items described in the prior art, the relevant question is whether the prior art combination would have been obvious to a person with ordinary skill in the art at the time of the invention. I have been further informed that it can be important to identify a teaching, suggestion, or motivation, in either the prior art or the knowledge of persons skilled in the art, that would have prompted a person of ordinary skill in the relevant field to combine the elements in the prior art in the way the claimed invention does.

19. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider, among other factors:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;

- whether a POSITA would implement a predictable variation, and would see the benefit of doing so;
- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by a POSITA;
- whether a POSITA would have recognized a reason to combine known elements in the manner described in the claim;
- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and
- whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

20. I have been informed and understand that one of ordinary skill in the art has ordinary creativity, and is not an automaton. I have been informed and understand that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered. I have been informed and understand that a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art.

21. I have been informed and understand that to show a motivation to combine, one is not required to show how the references would be physically combined to render a claim obvious. The analysis is not focused on whether the features of one reference can be physically incorporated into the structure of another reference, but rather whether a person of ordinary skill in the art would have been motivated to combine the teachings of the references to achieve the claimed invention. For example, a person of ordinary skill in the art would understand how predictable variations of known concepts could be combined and would recognize that where multiple tools were available in a “toolbox” of a POSITA, any tool could be chosen.

V. LEVEL OF ORDINARY SKILL IN THE ART

22. I have considered the '385 patent from the perspective of a POSITA at the time of the alleged invention. A person of ordinary skill in the art for the '385 patent would have had at least the equivalent of a bachelor's degree in computer science or electrical engineering and one to two years of experience in the field of wireless electronic devices and/or graphical user interfaces, particularly as those systems relate to software applications used to interface with wireless earpieces. This level of skill in the art is appropriate because many concepts of software applications, user interfaces, and electronic devices (such as wireless earpieces) were well known and widely taught in undergraduate courses. Moreover, an additional

two years of experience in the industry would give one of ordinary skill in the art experience with how such systems are implemented in the real world. Before November 13, 2015, which is the claimed priority date of the '385 patent, I would have qualified at least as a POSITA under this standard.

VI. OVERVIEW OF THE RELEVANT TECHNOLOGY AND THE '385 PATENT

A. The Alleged Invention

23. The '385 patent describes a software application with features that were commonly found in fitness tracking smartphone apps (e.g., iPhone and Android apps) that were available at the time. For example, the software application described in the '385 patent provides an interface to communicate with wireless earpieces, such as wireless headphones that can be paired with a smartphone via a Bluetooth connection. Ex-1001-USP385, 1:30-32 (“It is a further object, feature, or advantage of the present invention to provide a software application for communicating with one or more wireless ear pieces”), 3:61-63, 7:1-10.

24. Each independent claim of the '385 patent requires the software application to display a “visual representation” of the wireless earpieces. *Id.*, 7:30-

35, 8:23-25, 8:38-40. An example of the visual representation is shown in annotated Figure 6 below.¹



¹ All color annotations have been added to this and other figures in my Declaration.

As shown above, the visual representation shows the wireless earpieces 120 and 122 (red arrow) along with percentage figures 124 and 126 (green) that convey the remaining battery life of the earpieces. *Id.*, 6:1-19.

25. Certain claims of the '385 patent recite additional functionality of the software application such as music playback and activity monitoring. *See id.*, 1:33-36, (“It is a still further object, feature, or advantage of the present invention to provide a software application with features which support music playback functionality associated with one or more wireless ear pieces”), 1:37-40 (“Another object, feature, or advantage is to provide a software application with features which support various types of activity monitoring and recording functionality associated with one or more wireless ear pieces”).

26. However, the use of a software application to communicate with wireless earpieces was well-known before November 2015, which is the '385 patent's claimed priority date. As explained below, the prior art describes fitness tracking smartphone applications that communicate with wireless earpieces for a variety of purposes, such as to support music playback and to monitor fitness activities. In many cases, the software applications are a human machine interface which provides the user with a visual representation of the wireless earpieces on the smartphone display. The visual representation can be used to display remaining battery life and other data received from, or information related to, the earpieces.

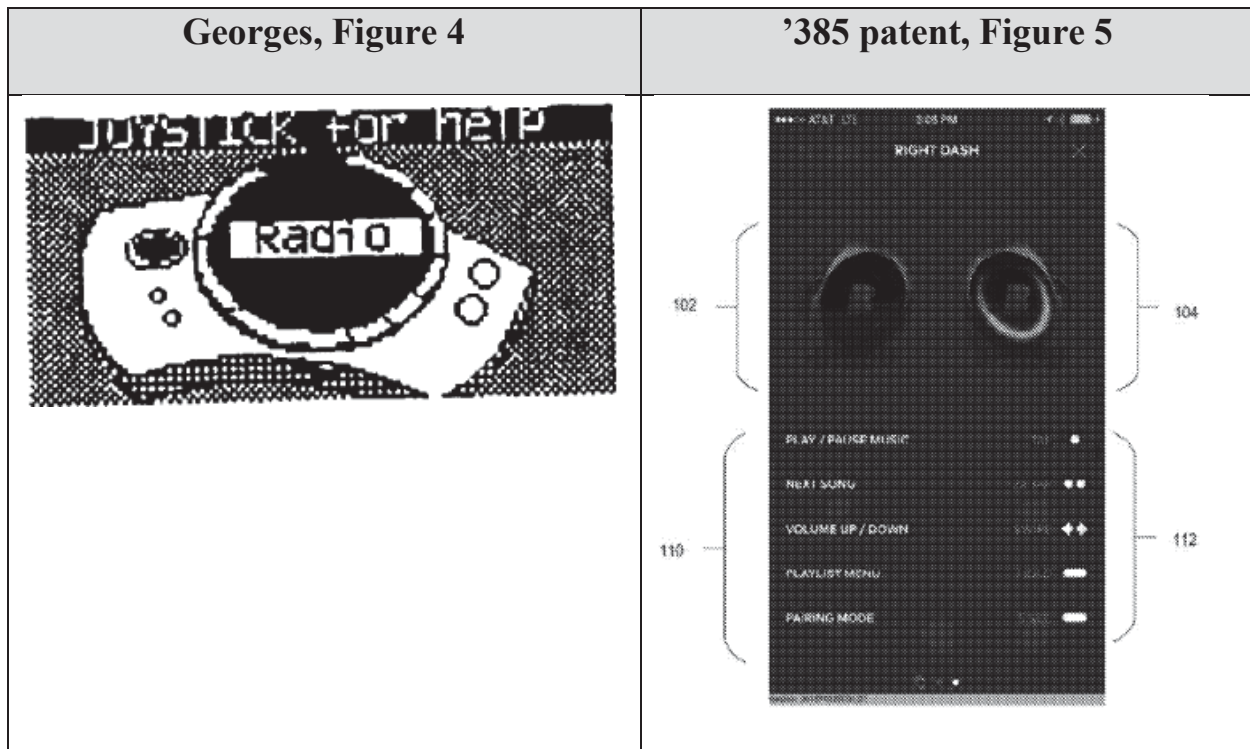
B. Examination Of The '385 Patent At The U.S. Patent Office

27. As stated on its cover page, the '385 patent was filed November 12, 2016, as U.S. Patent Application No. 15/350,020 (the "'020 application") and claims priority to U.S. Provisional Application No. 62/255,309 filed November 13, 2015.

28. The as-filed claims of the '020 application were initially rejected as being disclosed by prior art references. Ex-1011-FH [PDF139-144] (Office Action at 2-7). The applicant then filed a response to the rejection in which claim 1 was amended to recite the following limitations related to a "visual representation": "wherein the user interface is configured to display a visual representation of the at least one wireless ear piece on at least one of the one or more screen displays, the visual representation indicative of a function or property of the at least one wireless ear piece communicated from the at least one wireless earpiece to the computing device." Ex-1011-FH [PDF172] (Response at 2). Then-numbered independent claims 14 and 15 (now issued claims 13 and 14) were amended in similar fashion to recite: "wherein at least one of the one or more screen displays display a visual representation of the set of wireless ear pieces." Ex-1011-FH [PDF174-175] (Response at 4-5).

29. Next, the examiner rejected the amended claims and indicated that the applicant's new limitations related to the "visual representation" were disclosed by USP 7,022,906 ("Georges"). Ex-1011-FH [PDF195] (Office Action at 4). The

examiner identified a graphical depiction of a joystick shown in Figure 4 of Georges (reproduced below, alongside Figure 5 of the '385 patent for comparison) as corresponding to the claimed “visual representation.”



30. The applicant then filed an Appeal Brief arguing that Georges does not disclose the visual representation recited by the new limitations. The applicant attempted to differentiate Georges’ teachings from the claimed visual representation on the basis that the joystick shown in Georges Figure 4 is built into the display device and is not a separate wireless earpiece, and Georges’ depiction of the joystick is not based on a communication of a function or property of the joystick. Ex-1011-FH [PDF238-241] (Appeal Brief at 16-23).

31. After the applicant submitted its Appeal Brief, the examiner issued a notice of allowance without commenting on the applicant's arguments. The notice of allowance identified the limitations reciting the "visual representation," which were added by amendment, as the basis for allowance. Ex-1011-FH [PDF290] (Notice of Allowance at 2).

VII. OVERVIEW OF HENSEN PRIOR ART

32. Each of the Hensen prior art references (Hensen-Patent, Hensen-Video, and Hensen-Kickstarter) describe a wireless earpiece system designed and developed by physician Dr. Eric Hensen and a company that he founded, FreeWavz. The company website identifies the following features of the FreeWavz system:



Ex-1015. The diagram above indicates that the FreeWavz system includes a pair of wireless earpieces with built-in physiological sensors for heart rate and fitness

tracking. A companion software application (i.e., a smartphone app) is used to interact with the earpieces.

33. Further details about the FreeWavz system are found in Dr. Hensen's patent filings and product demonstrations, which are summarized below. For example, FreeWavz demonstrated the capabilities of its wireless earpiece system to the public through various online platforms, including YouTube (Hensen-Video) and Kickstarter (Hensen-Kickstarter). A POSITA seeking information about wireless earpiece systems at the time the '385 patent was filed would have readily found and accessed the information that FreeWavz made available on these platforms. For example, Kickstarter is (and was) a well-known site that companies use to inform interested members of the public about their products so as to attract small-scale investments in those products. Kickstarter campaigns often include detailed technical information to enable informed investment decisions. Accordingly, a POSITA looking to develop a wireless earpiece product like the one described in the '385 patent would have turned to Kickstarter as part of their due diligence given that it is valuable repository of information about similar/competing products.

A. Hensen-Patent

34. USP 9,781,514 ("Hensen-Patent") (Ex-1003) was filed October 8, 2015, and identifies Dr. Hensen as the sole inventor. Hensen-Patent is a

continuation-in-part of U.S. Patent Appl. No. 12/731,397 (“Hensen-Parent”) (Ex-1008), filed March 25, 2010. Hensen-Patent also claims priority to U.S. Provisional Appl. No. 62/061,497 (“Hensen-Provisional”) (Ex-1009), filed October 8, 2014. Hensen-Patent incorporates by reference the contents of Hensen-Parent and Hensen-Provisional. Ex-1003-Hensen-Patent, 1:5-17.

35. Hensen-Patent describes a wireless earpiece system with many of the same features as the system in the '385 patent. Figure 1 of Hensen-Patent is reproduced below.

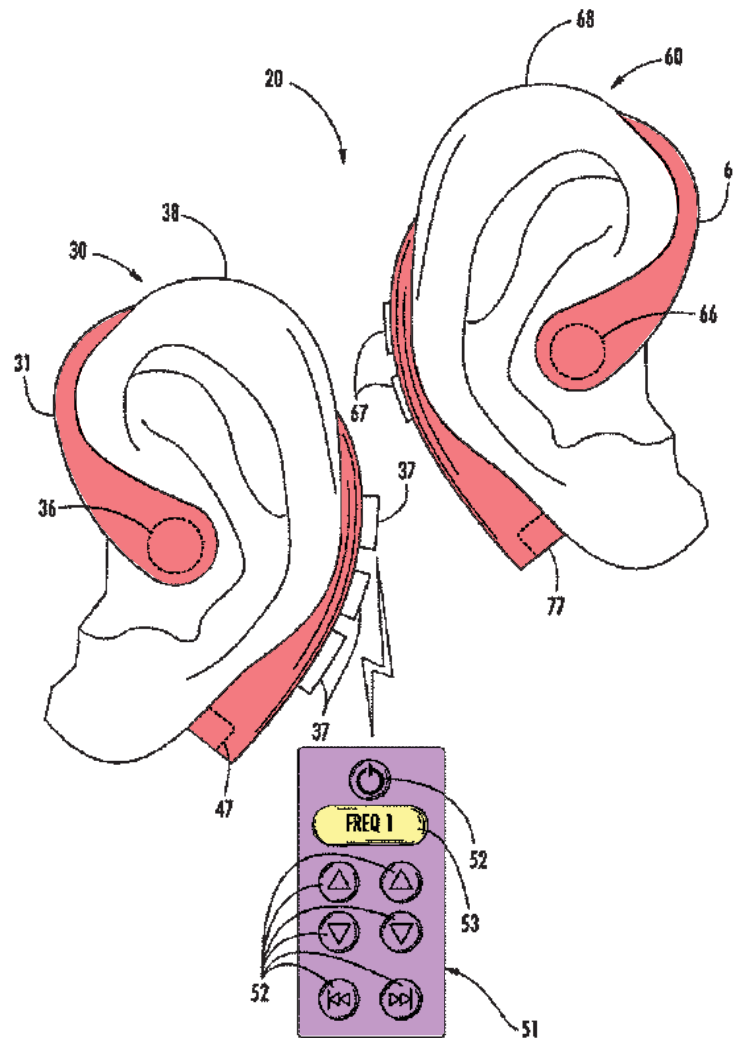


Figure 1 shows that system 20 includes a remote control device 51 (purple) that communicates wirelessly with a pair of earpieces 30 and 60 (red). Ex-1003-Hensen-Patent, Figure 1, 7:65-8:13, 8:24-34. Remote control device 51 includes a display 53 (yellow). Like the system in the '385 patent, Hensen-Patent's system 20 provides functionality such as music playback and monitoring battery life. Ex-1003-Hensen-Patent, Figure 1; *see also id.*, 8:14-23 ("The remote control unit 51 is configured to transmit commands, for example, to the master wireless receiver 35 [of headphone

unit 30]. Commands that may be transmitted include volume, and stereo audio source selection. For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 [sic: 51] may send commands for skipping to another song, or fast-forwarding through a song. The remote control unit 43 [sic: 51] may also send commands relating to the independent selection of the frequency equalization for the first and second stereo audio channels.”), 8:24-34 (“The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining.... Of course, the remote control unit 51 may send other commands and may display other information.”).

36. Through its incorporation by reference of Hensen-Provisional, Hensen-Patent also discloses that the wireless earpieces can have built-in pulse oximetry sensors to monitor the user’s fitness activities. Ex-1009-Hensen-Provisional, ¶¶1, 14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the ear-mounted device may be

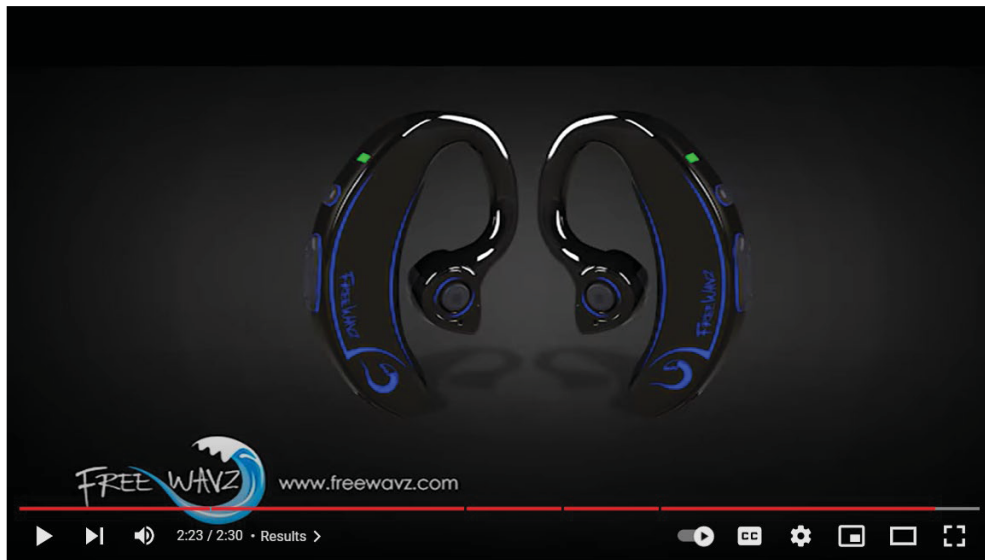
configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device.”), 35, 42.

B. Hensen-Video

37. In addition to the patent filings summarized above, Dr. Hensen disclosed features of the FreeWavz system through online platforms including the FreeWavz website, Twitter page, Kickstarter page, and YouTube channel. For example, Hensen-Video was published on the FreeWavz YouTube channel on September 10, 2015. A screenshot from Hensen-Video, which shows Dr. Hensen using the FreeWavz system, is shown below.

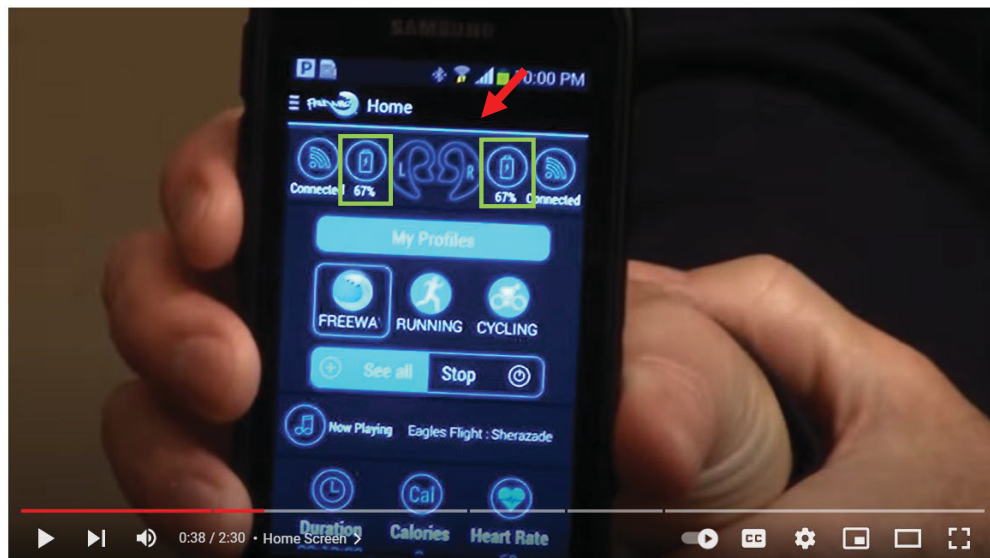


Ex-1004-Hensen-Video, 0:17. The above screenshot shows that the system includes a remote control device (purple) with a display (yellow) connected wirelessly to a pair of earpieces (red). Another screenshot, reproduced below, shows a close-up image of the left and right earpieces.



Id., 2:23 (close-up of earpieces); *see also id.*, 0:38 (close-up of remote control device).

38. Hensen-Video includes a demonstration of the smartphone user interface. For example, the “home” screen of the user interface is shown below.



Ex-1004-Hensen-Video, 0:32-0:38. The upper portion of the home screen includes a visual representation of the earpieces (red). The representation includes icons

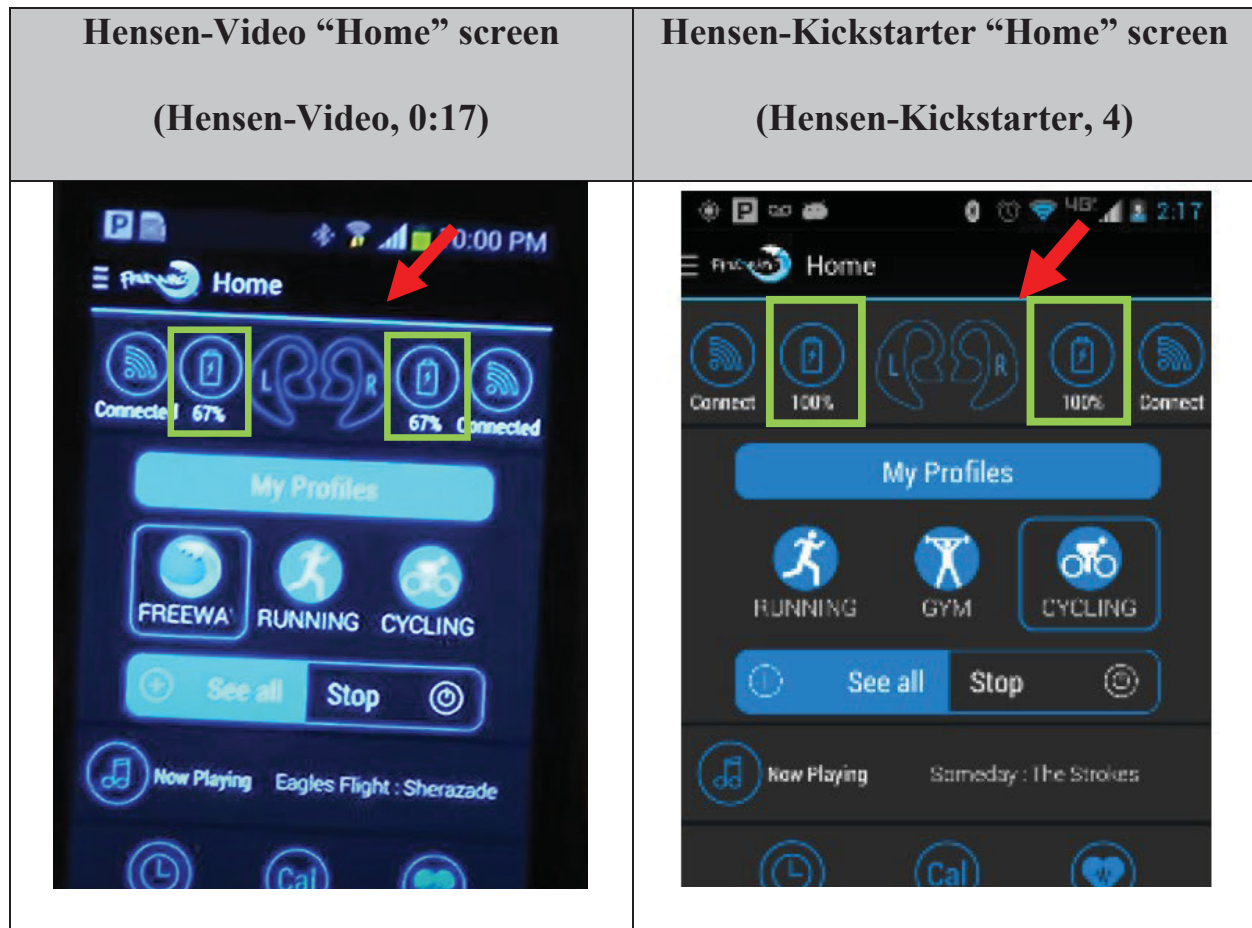
outlining the left (L) and right (R) earpieces and battery life indicators (green) for each earpiece. *Id.* (“I want to show you this home screen. I'm going to hold it real still. Now at the top you're going to see each unit and the battery life.”). The icons on the home screen have the same distinctive shape as the actual earpieces shown in the close-up image above.

C. Hensen-Kickstarter

39. Many of the same features of the FreeWavz system that were demonstrated in Hensen-Video were also published in Hensen-Kickstarter, a blog post published on Kickstarter on November 22, 2014. Ex-1007-Hensen-Kickstarter. For example, Hensen-Video and Hensen-Kickstarter both disclose that the FreeWavz system includes a pair of wireless earpieces, as shown below.



40. Moreover, as shown below, Hensen-Video and Hensen-Kickstarter both demonstrate the “home” screen of the FreeWavz smartphone user interface.



The above screenshots both show that the FreeWavz home screen includes a visual representation of the earpieces (red), which indicates their battery life (green).

VIII. CLAIM CONSTRUCTION

41. I understand that “claim construction” is the process of determining the meaning of a term or phrase in a patent claim. I have been informed that claim construction is a matter of law and that in this proceeding, claim construction will be determined by the Patent Trial and Appeal Board (“the Board”). I understand that

the proper construction of a term is how a POSITA would understand the term based on its use and context in the claims, specification, and file history of the patent. I further understand that the claims are not to be reviewed in this proceeding under the “broadest reasonable interpretation” standard.

42. In my opinion, the prior art discloses all of the limitations of the challenged claims under any plausible construction. I have been informed and understand that in such circumstances, there is no need to construe the terms in the challenged claims.

IX. ANALYSIS OF GROUNDS

A. Ground 1

43. As explained in detail below, claim 1-4 and 9-16 would have been obvious over the combined teachings of Hensen-Patent and Hensen-Video.

1. Claim 1

(a) [1Preamble] A system comprising:

44. I have been informed and understand that, in general, there are circumstances where the preamble of a claim does not limit the scope of the claim, and there are circumstances where the preamble does limit the scope of the claim. In any event, even if the preamble of claim 1 is limiting, Hensen-Patent discloses the claimed system.

45. Referring to annotated Figure 1 below, Hensen-Patent teaches a system 20 for interacting with wireless earpieces 30 and 60 (red).

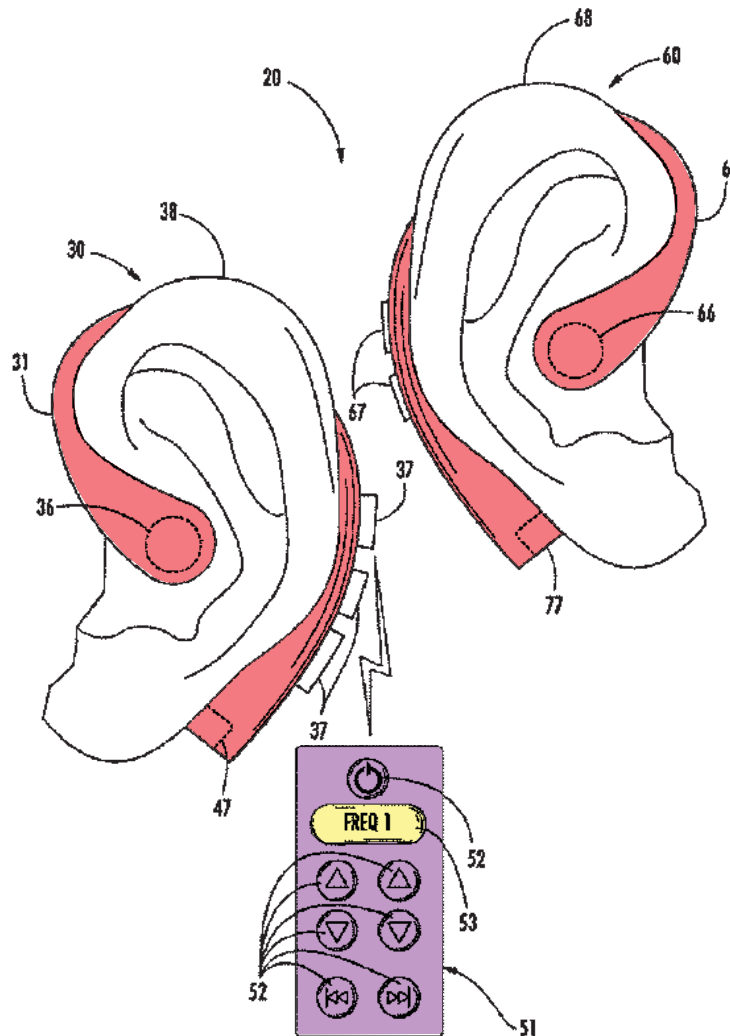


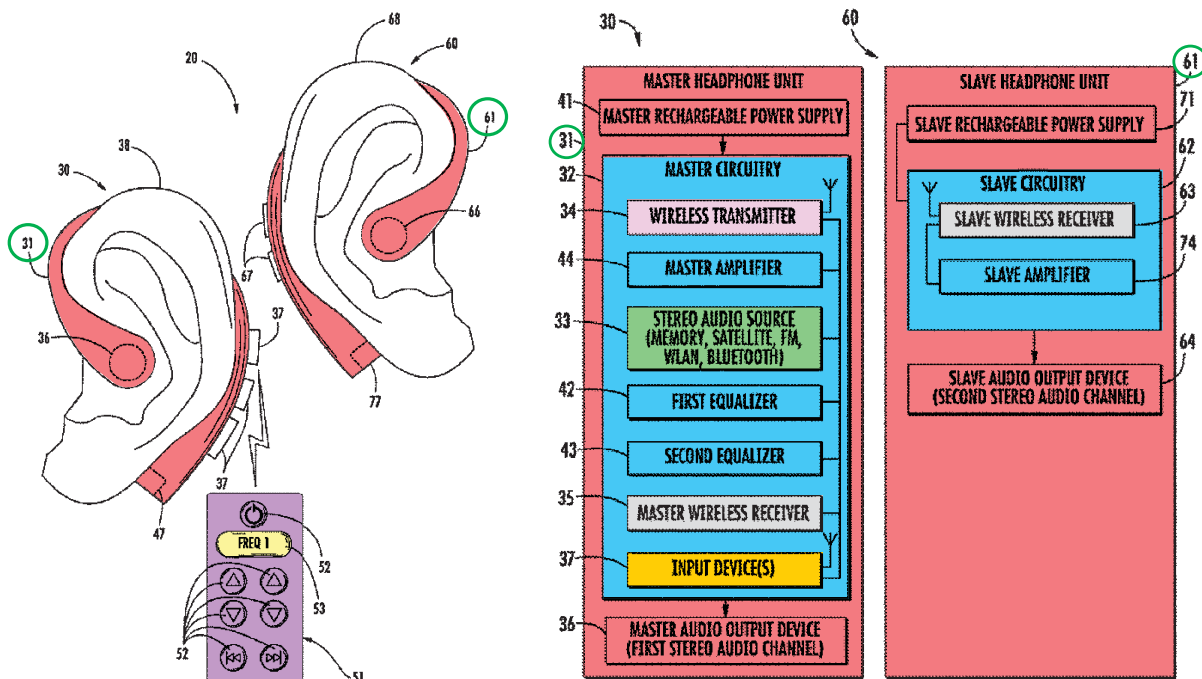
Figure 1 shows that a remote control device 51 (purple), which has a display 53 (yellow), communicates wirelessly with earpieces 30 and 60. For example, remote control device 51 sends commands to the earpieces and displays information received from the earpieces. Ex-1003-Hensen-Patent, 8:14-23 (“The remote control unit 51 is configured to transmit commands, for example, to the master

wireless receiver 35 [of headphone unit 30]. Commands that may be transmitted include volume, and stereo audio source selection. For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 [sic: 51] may send commands for skipping to another song, or fast-forwarding through a song. The remote control unit 43 [sic: 51] may also send commands relating to the independent selection of the frequency equalization for the first and second stereo audio channels.”), 8:24-34 (“The remote control unit 51 also illustratively includes remote control unit input devices 52, for example, push buttons, that correspond to the commands. The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining. The remote control unit 51 may advantageously send commands corresponding to ones of the input devices 37. Of course, the remote control unit 51 may send other commands and may display other information.”); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the ear-mounted device may be

configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device.”), 35, 42.

(b) [1A] at least one wireless ear piece comprising an ear piece housing and a wireless transceiver disposed within the ear piece housing;

46. Hensen-Patent teaches at least one wireless earpiece (e.g., headphone units 30 and 60) comprising an earpiece housing (e.g., housing 31 and 61, respectively) and a wireless transceiver (e.g., portions of circuitry 32 and 62 used for two-way wireless communication) disposed within the earpiece housing. These elements are shown in annotated Figures 1 and 2 below.



Ex-1003-Hensen-Patent, Figure 1 (left) and Figure 2 (right).

47. For example, Hensen-Patent teaches that headphone units 30 and 60 are wireless earpieces (e.g., they are “wireless” and are worn “behind the ear” / “ear-mounted”). Ex-1003-Hensen-Patent, 13:6-8 (“Moreover, the stereo audio headphone units 30, 60 advantageously are wireless and have a relatively low profile behind the ear”); *see also id.*, 2:24-31, 2:36-41, 4:55-64, 12:42-46, 12:52-55, Claim 1, Figure 1; Ex-1009-Hensen-Provisional, ¶¶14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the ear-mounted device may be configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device.”), 1, 35, 42.

48. In addition, Hensen-Patent teaches that headphone units 30 and 60 each have an earpiece housing (housings 31 and 61, respectively). Ex-1003-Hensen-Patent, 4:55-64 (“Referring initially to FIGS. 1-4, a stereo audio headphone apparatus 20 for a user having hearing loss illustratively includes a master headphone unit 30 that, in turn, includes a master housing 31 independently carried behind an ear 38 of the user. The master housing 31 is a behind the ear (BTE) housing and is arcuate in shape. The master housing 31 fits over the root of the helix of the

user's ear, as will be appreciated by those skilled in the art. The master housing 31 may be another type of housing, for example, an in-the-canal housing.”), 5:63-67 (“The slave headphone unit 60 illustratively includes a slave housing 61. The slave housing 61 is illustratively similar to the master housing 31 in size and shape, but the slave housing is configured to be independently carried behind another ear 68 of the user.”); *see also id.*, 2:24-31, 2:36-41, 4:55-64, 12:42-46, 12:52-55, Claim 1; Ex-1009-Hensen-Provisional, ¶¶17-19 (“The ear-mounted device 100 may comprise a proximal housing 200, an intermediate section 300, and a distal housing 400, The intermediate section 300 may be attached at a first end 302 to the proximal housing 200 and at a second end 304 to the distal housing 400. In some embodiments, one or more of the proximal housing 200, the intermediate section 300, and the distal housing 300 may be at least partially integrally formed.”).

49. Moreover, Hensen-Patent teaches that headphone units 30 and 60 each include a wireless transceiver, namely, circuitry 32 and 62 that is used to transmit and receive wireless communications. For example, circuitry 32 includes a wireless transmitter 34 and a wireless receiver 35. Ex-1003-Hensen-Patent, 4:66-67 (“The master circuitry [32] includes a stereo audio source 33 and a wireless transmitter 34 coupled thereto”), 8:14-23 (“The remote control unit 51 is configured to transmit commands, for example, to the master wireless receiver 35”). The wireless transceiver circuitry can also include a stereo audio source 33 and input devices 37.

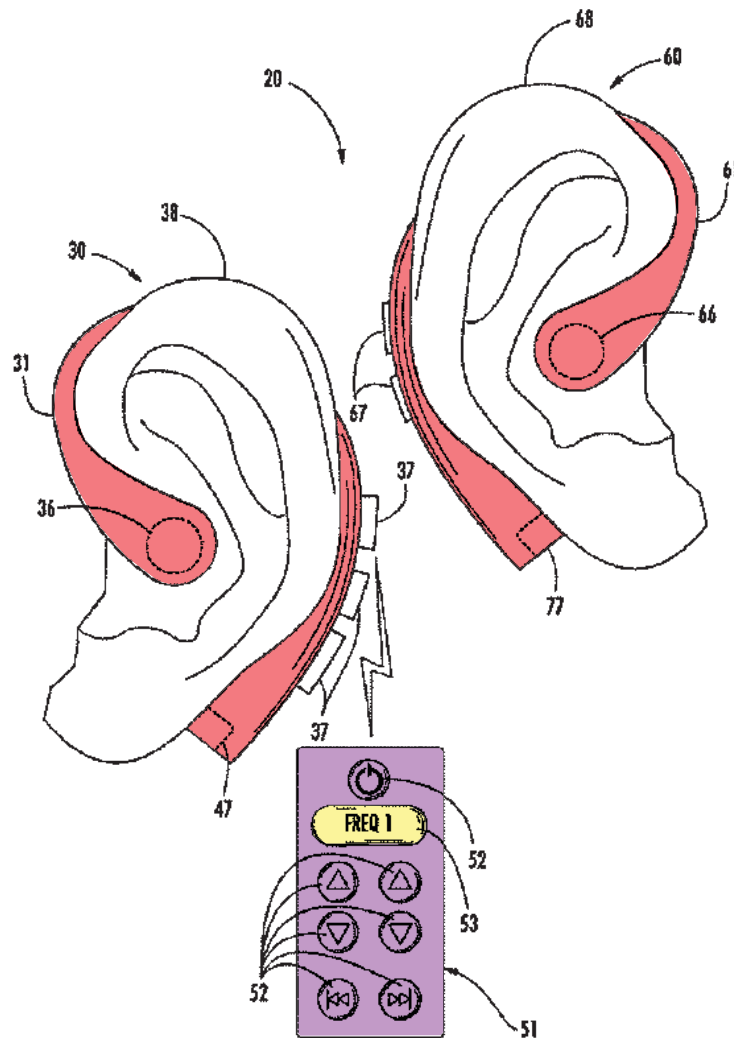
Id., 5:9-10 (“The stereo audio source 33 may be a stereo audio wireless receiver”), 8:24-34 (“The remote control unit 51 may advantageously send commands corresponding to ones of the input devices 37”); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42. Both headphone units 30 and 60 can generally include the same transceiver circuitry. Ex-1003-Hensen-Patent, 6:1-6 (“Slave circuitry 62 is also carried by the slave housing 61 and includes a slave wireless receiver 63 cooperating with the wireless transmitter 34. The slave wireless receiver 63 is configured to receive stereo audio, or the second stereo audio channel transmitted from the wireless transmitter 34, and is configured at an operating frequency corresponding to the wireless transmitter.”), 13:34-45 (“It is noted that in different embodiments, certain elements are described with regard to the master headphone unit 30. While these elements may not have been specifically described with regard to the slave headphone unit 60, as will be understood by those skilled in the art, the elements that are present in the master headphone unit 30 may also present in the slave headphone unit, for example, an input device, an audio input device, a power source, a recharging station port, and an independent audio impulse detector. The operation of these elements is similar to the corresponding ones in the master headphone unit 30, as will be appreciated by those skilled in the art.”).

50. Hensen-Patent also teaches that the wireless transceiver circuitry 32 and 62 is disposed within earpiece housings 31 and 61. Ex-1003-Hensen-Patent,

4:65 (“Master circuitry 32 is carried by the master housing 31”), 6:1 (“Slave circuitry 62 is also carried by the slave housing 61”), Figures 1 and 2; *see also* Ex-1009-Hensen-Provisional, ¶¶17, 21, Figures 1-4.

(c) *[1B] a software application for executing on a computing device having a display associated therewith;*

51. The combination of Hensen-Patent and Hensen-Video teaches a software application for executing on a computing device (e.g., remote control device 51) having a display (e.g., display 53) associated therewith. The remote control device 51 (purple) and display 53 (yellow) are shown in Figure 1 of Hensen-Patent below.



Ex-1003-Hensen-Patent, Figure 1.

(i) Hensen-Patent

52. As I explained for Element [1Preamble], Hensen-Patent teaches a remote control device that wirelessly communicates with earpieces, e.g., to send commands and display received information. Ex-1003-Hensen-Patent, 8:14-23 (“The remote control unit 51 is configured to transmit commands, for example, to the master wireless receiver 35 [of headphone unit 30]. Commands that may be

transmitted include volume, and stereo audio source selection. For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 [*sic*: 51] may send commands for skipping to another song, or fast-forwarding through a song. The remote control unit 43 [*sic*: 51] may also send commands relating to the independent selection of the frequency equalization for the first and second stereo audio channels.”), 8:24-34 (“The remote control unit 51 also illustratively includes remote control unit input devices 52, for example, push buttons, that correspond to the commands. The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining. The remote control unit 51 may advantageously send commands corresponding to ones of the input devices 37. Of course, the remote control unit 51 may send other commands and may display other information.”); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42.

(ii) Hensen-Video

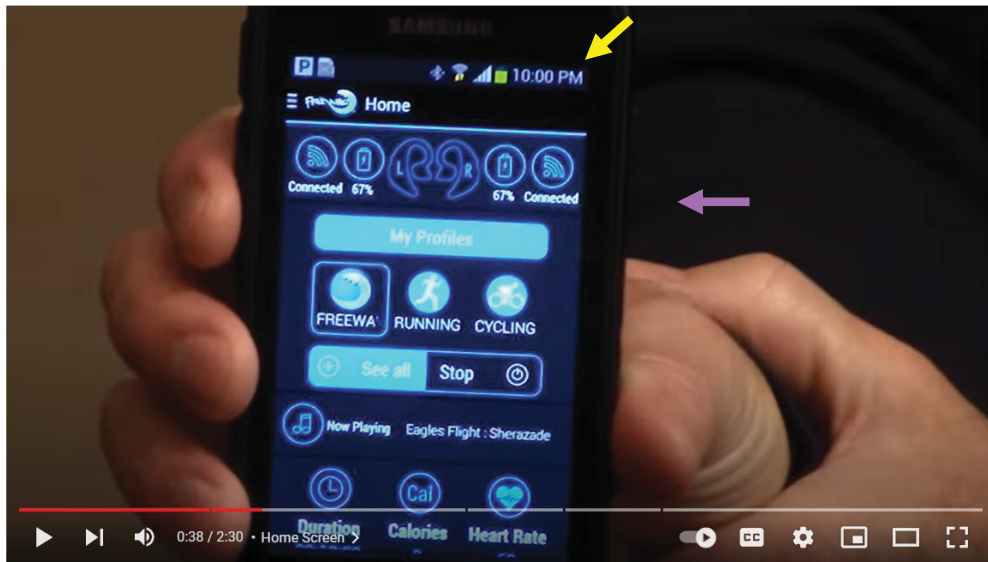
53. Hensen-Video also teaches a remote control device that wirelessly communicates with earpieces, and further teaches that the remote control device includes a software application executing on a smartphone computing device.

54. A screenshot from Hensen-Video, which depicts Dr. Hensen using the FreeWavz wireless earpiece system, is reproduced below.



Ex-1004-Hensen-Video, 0:17. The screenshot shows that the system includes two wireless earpieces (red arrows) and a remote control device (purple arrow) having a display (yellow arrow). *See id.*, 2:23 (close-up of earpieces), 0:38 (close-up of remote control device). Dr. Hensen states that remote control devices and the earpieces are wirelessly paired (i.e., via Bluetooth). *Id.*, 0:09-0:19 (“I’m currently wearing both the right and left units. I’ve already turned them on. I’ve paired them with each other and also paired with the source device, in this case, a smartphone.”).

55. Hensen-Video also teaches that the remote control device is implemented as a software application running on a smartphone. A screenshot of the software application (demonstrating the app’s “home” screen) is shown below.



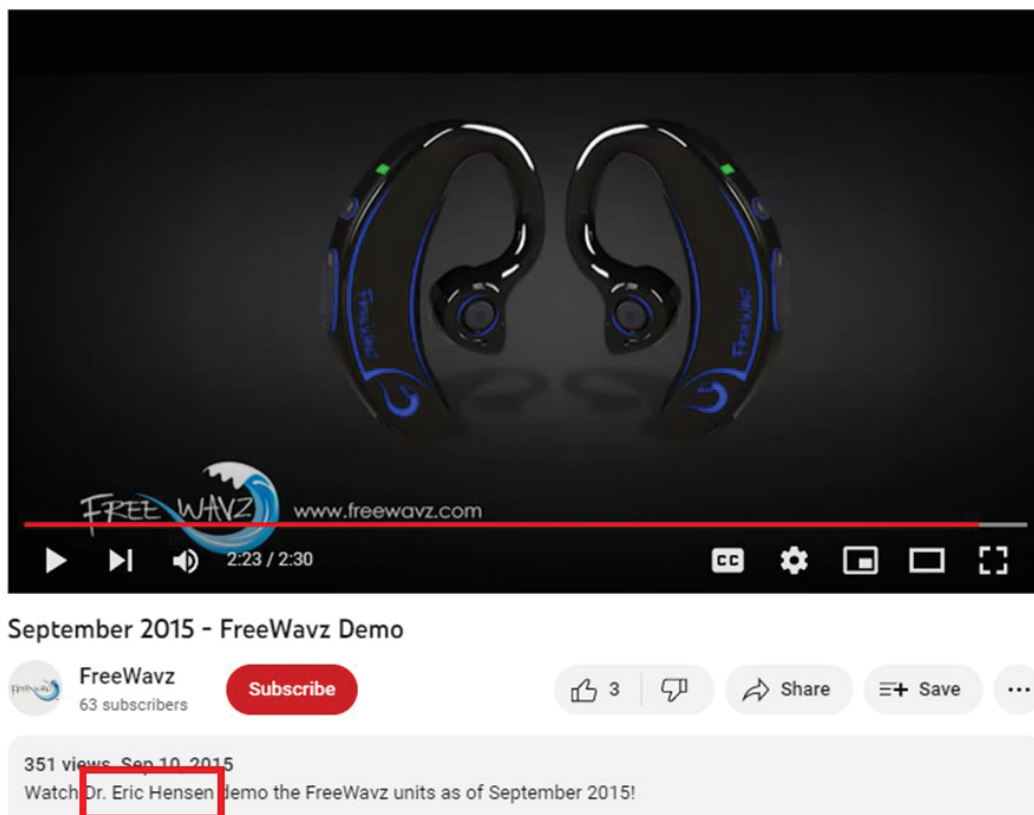
0:32-0:38 (“I want to show you this home screen. I’m going to hold it real still. Now at the top you’re going to see each unit and the battery life.”). In fact, the ’385 patent discloses embodiments in which the software application is an Android app like the one shown in Hensen-Video. Ex-1001-USP385, 7:1-10 (“an application may be [an] app ... developed for the Android operating system for an Android device”).

(iii) Motivation to Combine

56. As explained above, Hensen-Patent teaches a wireless earpiece system that includes wireless earpieces 30 and 60, remote control device 51, and display 53. *See* Element [1B(i)]. Hensen-Video teaches a similar wireless earpiece system in which the remote control device is implemented as a software application running on a smartphone computer device. *See* Element [1B(ii)]. As I explain below in greater detail, a POSITA would have been motivated to combine these teachings

with a reasonable expectation of success. In particular, a POSITA would have been motivated to adapt the wireless earpiece system in Hensen-Patent such that remote control device 51 would be implemented as a smartphone (e.g., an Android phone) running the software application demonstrated in Hensen-Video.

57. As an initial matter, Hensen-Video and Hensen-Patent are directly related to each other. As shown below, the narrator of Hensen-Video is Dr. Eric Hensen, who is also the named inventor of Hensen-Patent.



Ex-1004-Hensen-Video, 2:23; *see also* Ex-1003-Hensen-Patent, Cover Page (naming Dr. Hensen as the inventor). A POSITA therefore would have readily drawn a connection between the teachings of Hensen-Patent and Hensen-Video

through their common author/inventor. The references are also connected through the commercial product, FreeWavz, which is referenced throughout Hensen-Video (including by a link to the company website, www.freewavz.com). FreeWavz is described on the company website as being “doctor invented” and “patented,” and Dr. Hensen is again identified as the company founder. Ex-1015 (“doctor invented”); Ex-1016 (“patented”); Ex-1017 (Dr. Hensen biography). Thus, even a cursory investigation into the FreeWavz product shown in Hensen-Video would have guided a POSITA to Hensen-Patent (i.e., a patent that describes the same type of wireless earpiece system as Hensen-Video and lists Dr. Hensen as the inventor), which discloses further details of the wireless earpiece system demonstrated in Hensen-Video.

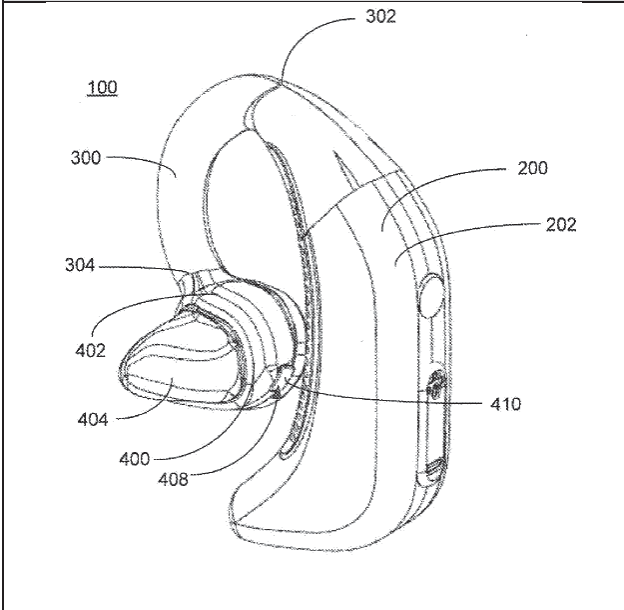
58. In addition, Hensen-Patent and Hensen-Video describe similar wireless earpiece systems, e.g., they both include a pair of wireless earpieces and a remote control device. Ex-1003-Hensen-Patent, 8:24-34 (“The remote control unit 51 also illustratively includes remote control unit input devices 52, for example, push buttons, that correspond to the commands. The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining. The remote control unit 51 may advantageously send commands corresponding to ones of the input devices 37. Of

course, the remote control unit 51 may send other commands and may display other information.”); Ex-1004-Hensen-Video, 0:09-0:19 (“I’m currently wearing both the right and left units. I’ve already turned them on. I’ve paired them with other and also paired with the source device, in this case, a smartphone.”). Hensen-Patent itself teaches that its remote control device can be a smartphone, which is the same type of remote control device used in Hensen-Video. Ex-1009-Hensen-Provisional, ¶35 (“The communication device [within the wireless earpieces] may be configured to communicate with a remote computerized device, either over a wired connection or a wireless connection. Such remote computerized devices may include... smart phones.”).

59. A POSITA would have appreciated various other similarities between the systems of Hensen-Patent and Hensen-Video, as would have been expected given the common source of the publications (i.e., Dr. Hensen). For example, both systems also have similar fitness tracking capabilities, e.g., the wireless earpieces can monitor pulse oximetry data and send it to the remote control device. Ex-1009-Hensen-Provisional, ¶14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the

ear-mounted device may be configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device.”); Ex-1004-Hensen-Video, 0:09-0:19 (“Right now I’m actually listening to some music and I’ve also engaged the pulse oximetry”), 0:48-1:09 (“I’m going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%. And that’s kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.”). Both systems are also used for similar applications, e.g., while the user is engaged in physical activities such as running and cycling. *See, e.g.,* Ex-1009-Hensen-Provisional, ¶14 (“The ear-mounted device may be removably attached to an ear of the user so as to resist unintended detachment during periods of activity by the user, such as any type of exercise or athletic endeavor, including, but not limited to, **running**, jogging, stretching, acrobatics, aerobics, **cycling**, swimming, and any other type of high-impact, low-impact, or no impact exercise as is known”); Ex-1004-Hensen-Video, 0:38 (user-selectable activities include “running” and “cycling”). Likewise, both systems support music playback functionality. *See, e.g.,* Ex-1003-Hensen-Patent, 5:41-44 (stereo audio source can be a “memory having stereo audio (music) stored thereon”), 8:17-20, 12:65-13:5 (“The stereo audio headphone apparatus 20 may be particularly advantageous to a user having hearing loss that may wish to listen to music, for example, by permitting independent selection of

frequency equalization”); Ex-1004-Hensen-Video, 0:09-0:19 (“Right now I’m actually listening to some music and I’ve also engaged the pulse oximetry”). Even the aesthetic design of the wireless earpieces depicted in Hensen-Patent and Hensen-Video are remarkably similar:

Hensen-Provisional, Figure 1	Hensen-Video, 2:23
 A technical line drawing of a wireless earpiece, labeled 100. It shows a side profile of the device with various components labeled: 300 (the main body), 302 (a curved part at the top), 200 (a side section), 202 (a small circular feature), 304 (a protruding part), 402 (a small circular feature), 404 (a small rectangular feature), 400 (a larger circular feature), 408 (a small circular feature), and 410 (a small rectangular feature).	 A photograph of a sleek, black wireless earpiece. It has a curved, ergonomic design. There are blue accents, including a blue line running along the side and a blue circular feature near the ear. The device is shown against a dark background.

60. A POSITA would have recognized the benefits of combining Hensen-Video’s teachings with those of Hensen-Patent. For example, Hensen-Video teaches that its software application advantageously provides the ability to read and display data from the wireless earpieces via a touchscreen user interface. *See, e.g.*, Ex-1004-Hensen-Video, 0:32-0:38 (“I want to show you this home screen. I’m going to hold it real still. Now at the top you’re going to see each unit and the battery life.”), 0:43-0:48 (“You can also see down below here is my heart rate at 60”), 1:09-1:24 (“I’m

going to demonstrate the raw data that has been obtained. If you can see that red line, that is our waveform. That is where our raw data is being obtained from -- that is, the heart rate and the oxygen saturation.”); *see also* Ex-1015 (“Easy to Use App: Quick easy interface allows completely customizable and inspiring workouts!”). Thus, a POSITA would have recognized Hensen-Video’s teachings as having the potential to improve Hensen-Patent’s wireless earpiece system, e.g., by allowing the combined system to benefit from the smartphone’s display and touchscreen interface.

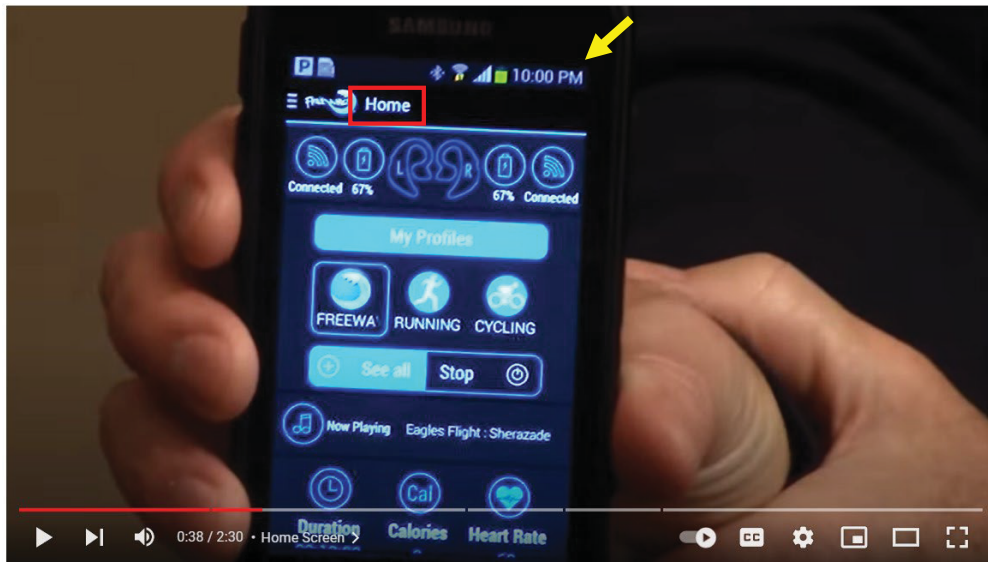
61. A POSITA would have combined Hensen-Video’s teachings with those of Hensen-Patent with a reasonable expectation of success because Hensen-Video merely discloses implementation details of Hensen-Patent’s remote control device. For example, Hensen-Patent teaches that remote control device 51 can include a software application running on a smartphone computing device, and Hensen-Video discloses further details about the software application. Ex-1003-Hensen-Patent, 5:9-24 (“Still further, the stereo audio wireless receiver may be a Bluetooth or wireless local area network (WLAN) receiver to wirelessly receive stereo audio therefrom, for example, as may be transmitted from a mobile wireless communications device (i.e. cellular telephone), or over an Internet transmission.”); Ex-1009-Hensen-Provisional, ¶35 (“The communication device may be configured to communicate with a remote computerized device, either over a wired connection

or a wireless connection. Such remote computerized devices may include, but are not limited to, smart phones, tablet computers, personal computers, notebook computers, and the like.”). Accordingly, a wireless earpiece system using the combined teachings of Hensen-Video and Hensen-Patent would have been implemented by routine techniques well within the skill of a POSITA and would have yielded predictable results—e.g., remote control device 51 being implemented as a software application on a smartphone computing device—with a reasonable expectation of success.

(d) [1C] wherein the software application configured to display one or more screen displays on a display of the computing device;

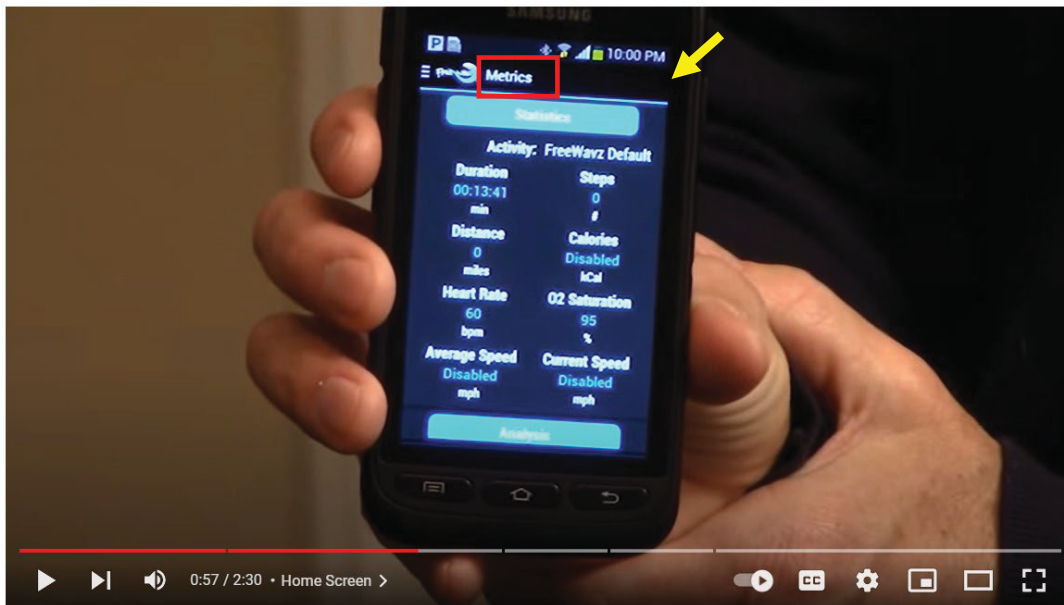
62. As I explained for Element [1B], Hensen-Video teaches a software application running on a smartphone computing device. Hensen-Video further teaches that the software application is configured to display one or more screen displays on a display (e.g., a touchscreen) of the smartphone computing device.

63. For example, the screenshot below shows a “home” screen display that the FreeWavz software application displays on the touchscreen display (yellow) of the smartphone computing device.



Ex-1004-Hensen-Video, 0:32-0:38 (“I want to show you this home screen. I'm going to hold it real still. Now at the top you're going to see each unit and the battery life.”).

64. In another example, the screen shot below shows a “metrics” screen display that the FreeWavz software application displays on the touchscreen display (yellow arrow) of the smartphone computing device.

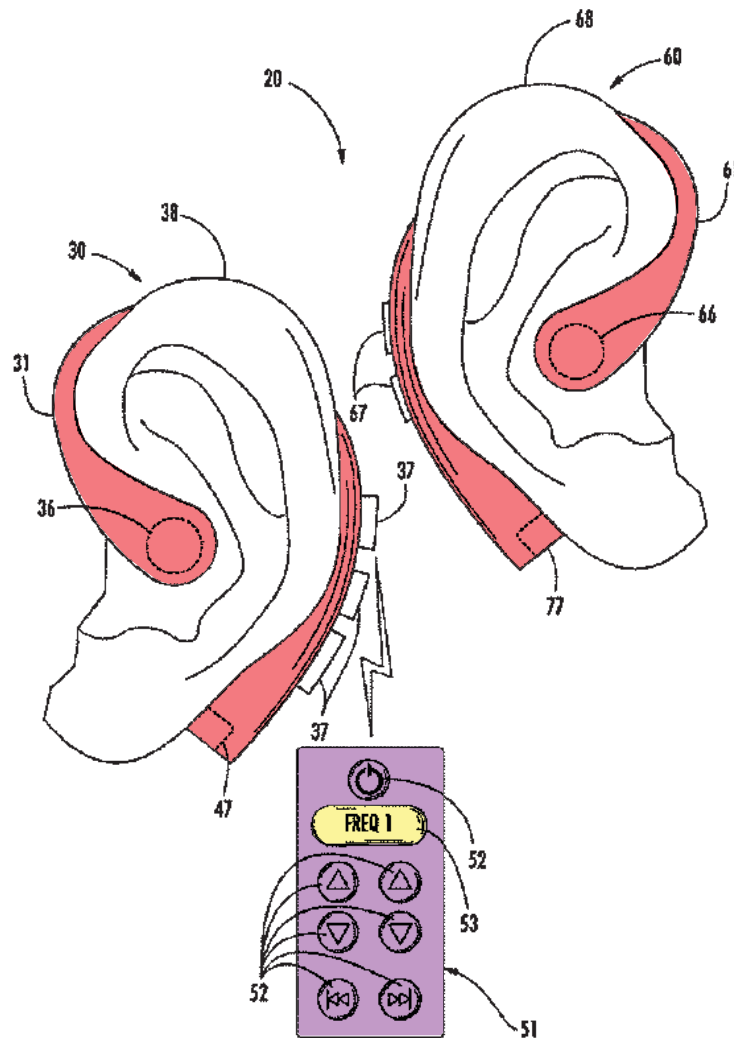


Ex-1004-Hensen-Video, 0:48-1:09 (“I’m going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%. And that’s kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.”).

65. A POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success for the same reasons that I explained previously for Element [1B]. Furthermore, Hensen-Patent teaches that remote control device 51 displays information associated with wireless earpieces 30 and 60, and Hensen-Video provides mechanisms for doing so when remote control device 51 is implemented as a software application on a smartphone computing device.

- (e) [1D] wherein the software application provides a user interface for use by a user of the at least one wireless ear piece to interact with the at least one wireless ear piece; and;

66. As I explained for Element [1B], the combination of Hensen-Patent and Hensen-Video teaches a wireless earpiece system that includes a software application and at least one wireless earpiece. The combination further teaches that the software application provides a user interface (e.g., a user interface of remote control device 51) for use by a user of the at least one wireless earpiece (e.g., headphone units 30 and 60) to interact with the at least one wireless earpiece.



Ex-1003-Hensen-Patent, Figure 1.

(i) Hensen-Patent

67. As I explained for Element [1Preamble] and [1B], Hensen-Patent teaches a remote control device that allows a user to interact with the earpieces, e.g., by sending commands and displaying received information received. *Id.*, 8:14-23 (“The remote control unit 51 is configured to transmit commands, for example, to the master wireless receiver 35 [of headphone unit 30]. Commands that may be

transmitted include volume, and stereo audio source selection. For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 [sic: 51] may send commands for skipping to another song, or fast-forwarding through a song. The remote control unit 43 [sic: 51] may also send commands relating to the independent selection of the frequency equalization for the first and second stereo audio channels.”), 8:24-34 (“The remote control unit 51 also illustratively includes remote control unit input devices 52, for example, push buttons, that correspond to the commands. The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining. The remote control unit 51 may advantageously send commands corresponding to ones of the input devices 37. Of course, the remote control unit 51 may send other commands and may display other information.”); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42.

(ii) Hensen-Video

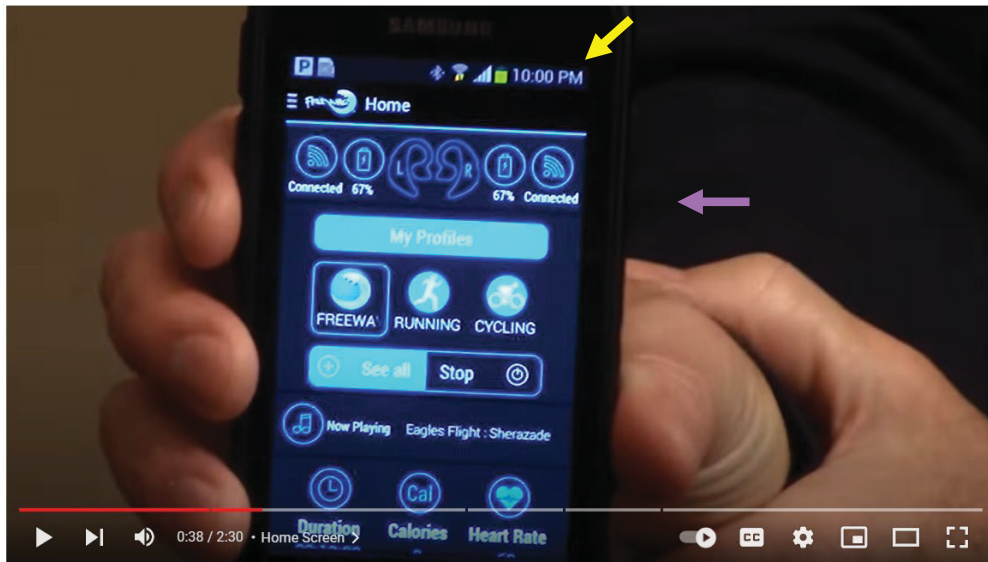
68. As I explained Element [1B], Hensen-Video teaches a remote control device like the one in Hensen-Patent, where the remote control device is implemented as a software application running on a smartphone. Hensen-Video further demonstrates the software application provides a user interface for use by a user of the at least one wireless earpiece.

69. A screenshot from Hensen-Video is shown below.



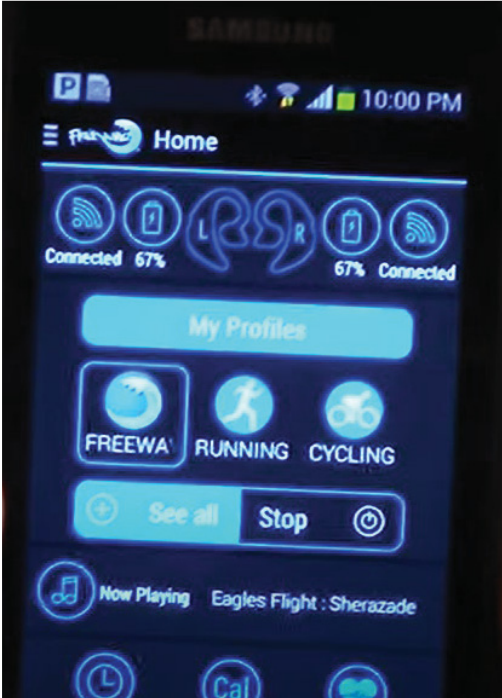
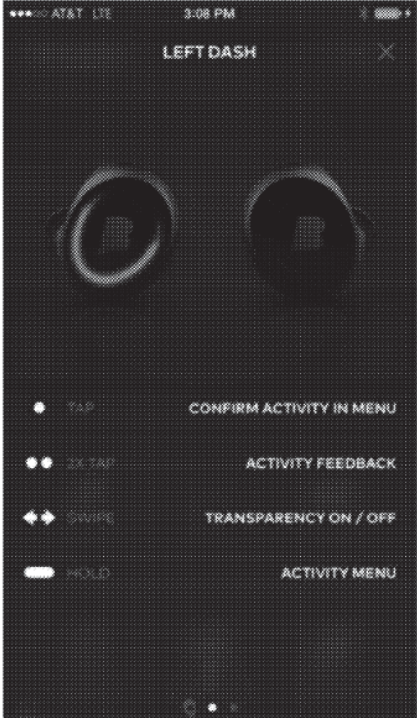
Ex-1004-Hensen-Video, 0:09-0:19. Dr. Henson is pictured as the user of the earpieces (red arrows) and is also holding a smartphone (purple arrow). *Id.* (“I’m currently wearing both the right and left units. I’ve already turned them on. I’ve paired them with each other and also paired with the source device, in this case, a smartphone.”). Dr. Hensen uses the touchscreen user interface of the smartphone display (yellow arrow) to interact with the earpieces. *See id.*, 0:28-1:28 (showing Dr. Hensen performing operations via the touchscreen user interface of the smartphone display).

70. Another screenshot from Hensen-Video demonstrating the “home” screen display of the Freewavz user interface is shown below.



Ex-1004-Hensen-Video, 0:32-0:38. The screenshot shows that the home screen display provides a user interface for Dr. Hensen to monitor the battery life of the earpieces. *Id.* (“I want to show you this home screen. I'm going to hold it real still. Now at the top you're going to see each unit and the battery life.”).

71. During examination of the '385 patent, the applicant identified Figure 4 as providing written description support for Element [1D]. Ex-1011-FH, [PDF229] (Appeal Brief at 8). Figure 4 is reproduced below side-by-side with Hensen-Video's home screen display.

Hensen-Video, 0:17	'385 patent, Figure 4
	

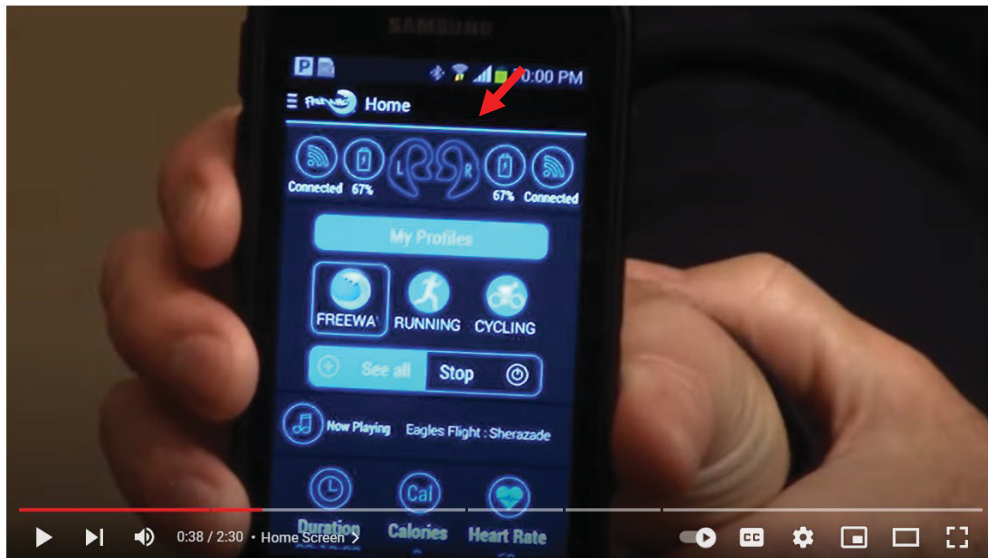
As above below, the user interface shown in Hensen-Video bears many similarities to the embodiment shown in Figure 4 of the '385 patent, including the use of a visual representation of the earpieces that I will explain further below (*see* Element [1E]).

72. As I explained for Element [1B], a POSITA would have been motivated to combine the teachings of Hensen-Patent and Hensen-Video with a reasonable expectation of success. Furthermore, Hensen-Patent teaches that remote control device 51 displays information associated with wireless earpieces 30 and 60, and Hensen-Video provides mechanisms for doing so when remote control device 51 is implemented as a software application on a smartphone computing device.

- (f) [1E] wherein the user interface is configured to display a visual representation of the at least one wireless ear piece on at least one of the one or more screen displays.

73. As I explained for Element [1D], the combination of Hensen-Patent and Hensen-Video teaches a user interface, e.g., Hensen-Patent's remote control device implemented using Hensen-Video's touchscreen user interface. Hensen-Video further teaches that the user interface is configured to display a visual representation of the at least one wireless earpiece on one or more screen displays (e.g., on the "home" screen display).

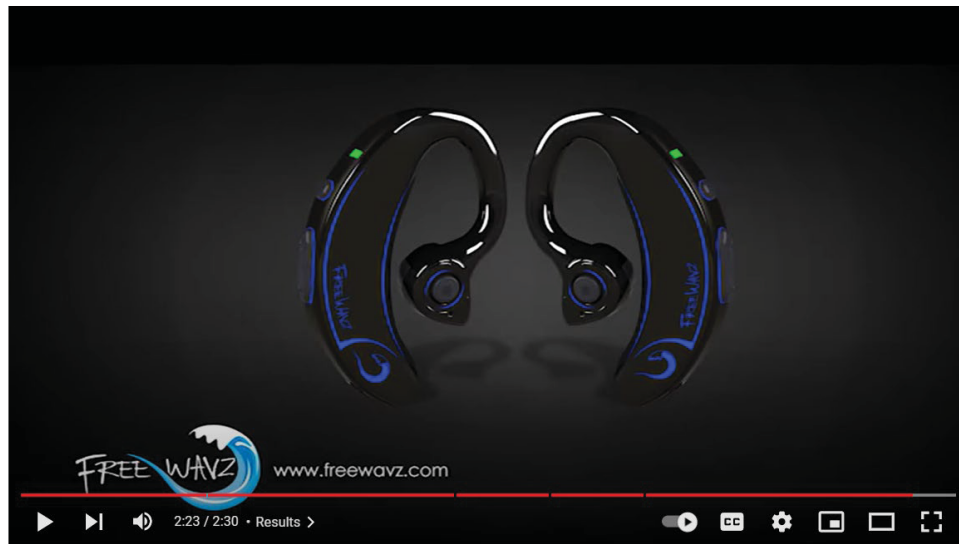
74. Hensen-Video's "home" screen display is reproduced below.



Ex-1004-Hensen-Video, 0:32-0:38 ("I want to show you this home screen. I'm going to hold it real still."). The upper portion of the home screen display includes a visual representation of the left (L) and right (R) earpieces, e.g., the pair of icons that are immediately recognizable as depicting silhouettes or outlines of the

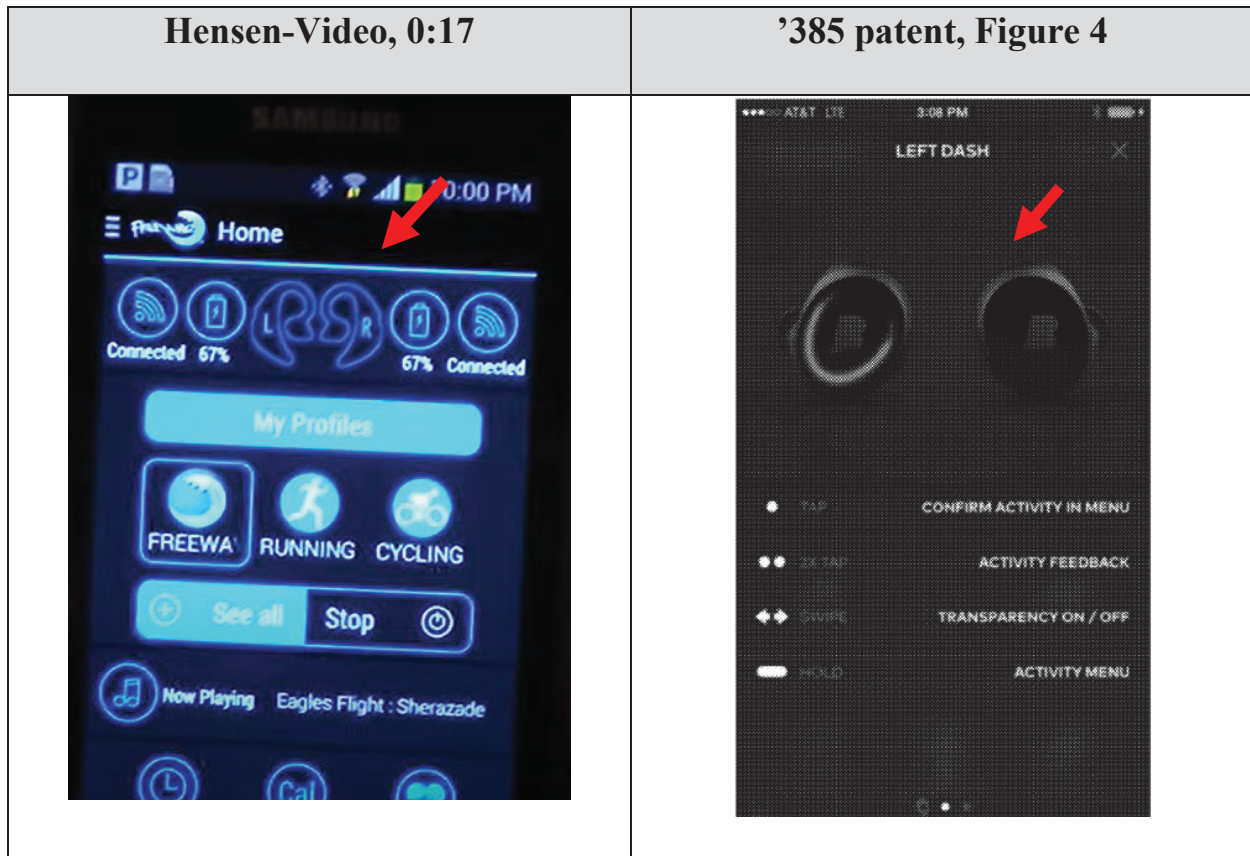
earpieces. Dr. Hensen identifies these icons as constituting a visual representation of the earpieces in his narration. *Id.* (“Now at the top you’re going to see each unit [(i.e., earpiece)].”).

75. The actual earpieces are depicted in the screenshot below.



Ex-1004-Hensen-Video, 2:23. The actual earpieces have the same physical profile as the icons appearing at the top of the home screen display, consistent with the icons being a visual representation of the earpieces.

76. During examination of the '385 patent, the applicant identified Figure 4 as providing written description support for Element [1E]. Ex-1011-FH, [PDF229] (Appeal Brief at 8). Figure 4 is reproduced below side-by-side with Hensen-Video's home screen display.



As shown above, the visual representation of the earpieces (red arrow) in Hensen-Video bears many similarities to the embodiment shown in Figure 4 of the '385 patent, e.g., both visual representations show the two earpieces (left and right) as mirror images of each other, centered on the display, and with approximately the same dimensions relative to other elements shown on the user interface (e.g., they occupy a similar fraction of the overall display screen). Moreover, both visual representations depict the earpieces in a similar level of detail, conveying the shape of the actual earpieces with relatively high similarity to the physical structure.

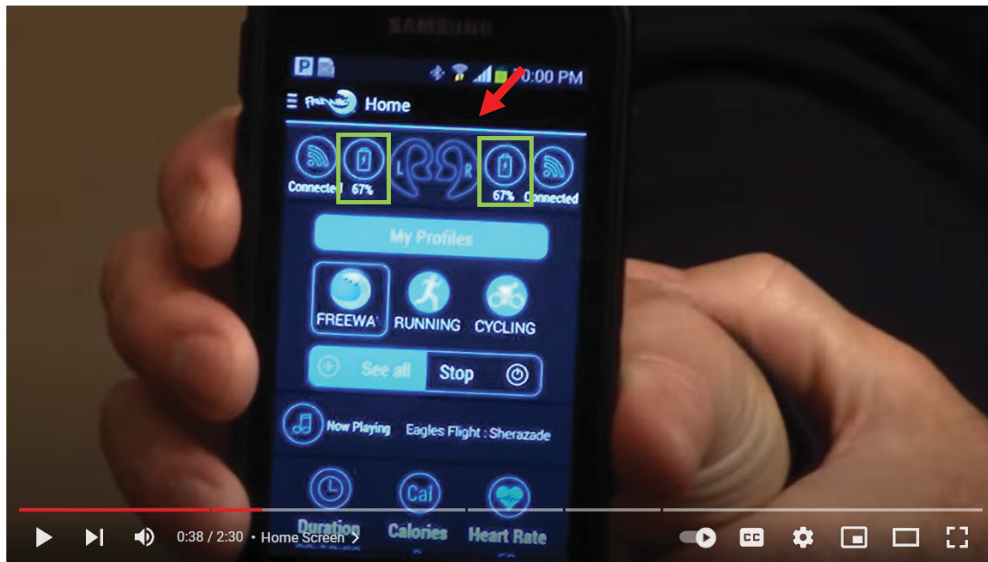
77. As I explained for Element [1B], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of

success. Furthermore, Hensen-Patent teaches that its remote control device 51 is used to display remaining battery life of earpieces 30 and 60, (Ex-1003-Hensen-Patent, 8:24-34), and Hensen-Video provides mechanisms for doing so when remote control device 51 is implemented as a software application on a smartphone computing device.

(g) [1F] the visual representation indicative of a function or property of the at least one wireless ear piece communicated from the at least one wireless earpiece to the computing device.

78. As I explained for Element [1E], Hensen-Video's user interface displays a visual representation of the at least one wireless earpiece. Hensen-Video further teaches that the visual representation is indicative of a function or property of the at least one wireless earpiece communicated from the at least one wireless earpiece to the computing device (e.g., battery life).

79. An annotated screenshot of Hensen-Video's "home" screen display is shown below.

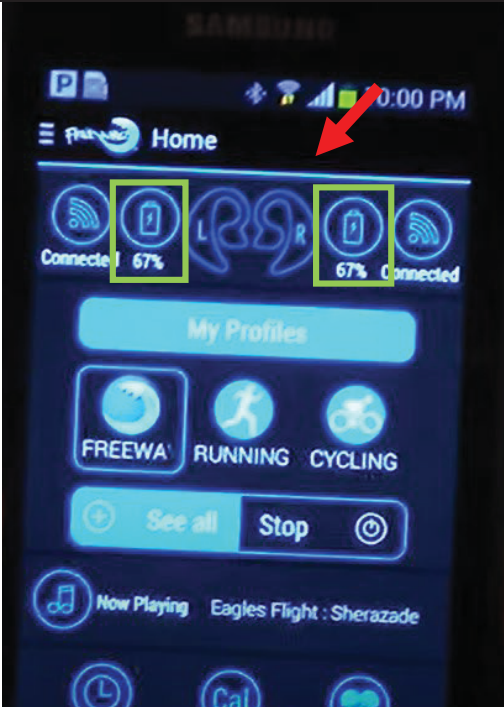
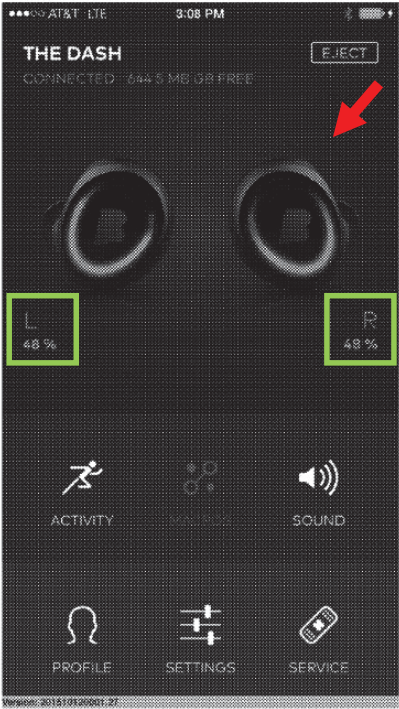


Ex-1004-Hensen-Video, 0:32-0:38 (“I want to show you this home screen”). The screenshot shows that the visual representation is indicative of the battery life (green) of each of the earpieces. For example, due to the proximity of the battery life indicators to the earpiece icons, a user can readily determine which earpiece is associated with each indicator. In his narration, Dr. Hensen states that the visual representation of the earpieces is indicative of the battery life. Ex-1004-Hensen-Video, 0:32-0:38 (“Now at the top you're going to see each unit and the battery life.”).

80. Battery life is a property of an earpiece that is communicated from the earpiece to the computing device (e.g., the remote control device / smartphone). Namely, a POSITA would have understood a smartphone does not have a priori knowledge of the earpiece battery life; instead, the smartphone receives the battery life information (or a related property of the earpiece from which battery life can be

derived) from the earpieces. Therefore, the battery life information is communicated from the earpiece to the smartphone.

81. During examination of the '385 patent, the applicant identified the battery life indicators shown in Figure 6 as providing written description support for Element [1F]. Ex-1011-FH, [PDF229] (Appeal Brief at 8) (citing Specification 8:16-17 as supporting limitation [1F]; this passage describes Figure 6 and states: “Underneath the ‘L’ is textual [*sic*: textual] information in the form of a numerical representation 124 of remaining battery life for the left ear piece”). Figure 6 is reproduced below side-by-side with Hensen-Video’s home screen display.

Hensen-Video, 0:17	'385 patent, Figure 6
 A screenshot of a smartphone screen displaying the Hensen-Video app. At the top, the status bar shows 'SAMSUNG', signal strength, Wi-Fi, and the time '10:00 PM'. Below the status bar, there are icons for 'Connect', a battery icon with '67%', a left earpiece icon 'L', a right earpiece icon 'R', another battery icon with '67%', and a 'Connected' status. A red arrow points to the '67%' battery indicator for the right earpiece. Below these icons is a 'My Profiles' section with buttons for 'FREEWAY', 'RUNNING', and 'CYCLING'. At the bottom, there is a 'Now Playing' section showing 'Eagles Flight : Sherazade'.	 A screenshot of a smartphone screen displaying the '385 patent Figure 6. The status bar at the top shows 'AT&T LTE', signal strength, Wi-Fi, and the time '3:08 PM'. Below the status bar, there is a 'THE DASH' section with 'CONNECTED' status and '644.5 MB GB FREE'. A red arrow points to the 'EJECT' button in the top right corner. Below the status bar, there are two circular icons representing earpieces. The left earpiece icon is labeled 'L' and has a battery indicator showing '48 %'. The right earpiece icon is labeled 'R' and has a battery indicator showing '48 %'. Below these icons are buttons for 'ACTIVITY', 'VALUES', and 'SOUND'. At the bottom, there are buttons for 'PROFILE', 'SETTINGS', and 'SERVICE'. A small text at the bottom left reads 'Version: 201510120001.27'.

As shown above, the battery life indicators (green) in Hensen-Video bears many similarities to the embodiment shown in Figure 6 of the '385 patent, e.g., both battery life indicators state the remaining battery life as a percentage and are positioned in proximity to the icons of the earpieces (red arrows) to visually identify which battery life indicator corresponds to which earpiece.

82. In addition, the '385 patent includes a dependent claim (Claim 7, which depends indirectly from claim 1) that specifies that remaining battery life is a property of the earpiece that satisfies Element [1F]. Ex-1001-USP385, Claim 7 (“The system of claim 6 wherein the property is remaining battery life”).

83. As I explained for Elements [1B]-[1D], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success. Furthermore, Hensen-Patent teaches that its remote control device 51 is used to display remaining battery life of earpieces 30 and 60, (Ex-1003-Hensen-Patent, 8:24-34), and Hensen-Video provides mechanisms for doing so when remote control device 51 is implemented as a software application on a smartphone computing device.

2. Claim 2: The system of claim 1 wherein the at least one wireless earpiece comprises a physiological sensor.

84. As I explained in Section VII.A, Hensen-Patent incorporates by reference the content of Hensen-Provisional. Ex-1003-Hensen-Patent, 1:11-17.

Through these incorporated teachings, Hensen-Patent teaches a wireless earpiece comprising a physiological sensor (e.g., an integrated pulse oximeter). Ex-1009-Hensen-Provisional, ¶¶1 (“The present invention relates to systems and methods for ear-mounted devices with integrated pulse oximetry capability”), 14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user.”), 17, 21-23, 25, 26, 29, 30, 33, 34, 42, 47, 50.

85. Figure 4 of Hensen-Provisional is reproduced below.

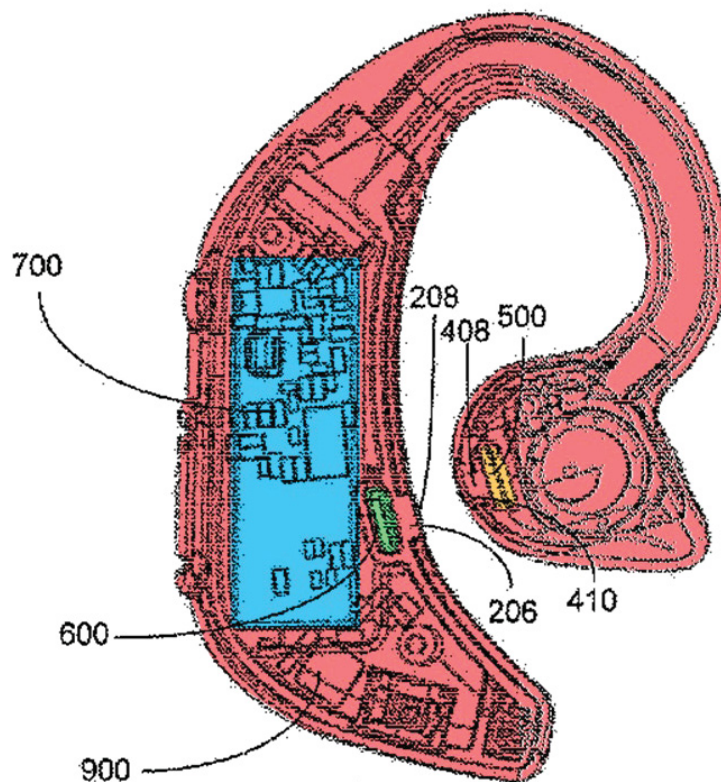


Figure 4 shows an ear-mounted device 100 (red) with a physiological sensor (e.g., the integrated pulse oximeter) that includes a radiation emitting device 500 (orange), a radiation sensing device 600 (light green), and processing circuitry 700 (blue). These components of the physiological sensor operate together to perform pulse oximetry. Ex-1009-Hensen-Provisional, ¶¶21, 30, 33, 42. During examination of the '385 patent, the applicant identified such a pulse oximeter as a type of physiological sensor that satisfies claim 2. Ex-1011-FH [PDF229] (Appeal Brief at 8) (citing Specification 5:2 as supporting claim 2; this passage indicates that the physiological sensor can be “a pulse oximeter 76, a temperature sensor 80, or other physiological or biological sensor(s)”).

86. A POSITA would have understood Hensen-Patent’s teachings to include configurations in which its wireless earpiece system includes the pulse oximetry and activity monitoring functionality described in Hensen-Provisional. For example, Hensen-Provisional’s states that its teachings build upon and are consistent with the wireless earpiece system disclosed in Hensen-Parent (i.e., the parent of Hensen-Patent, which was filed in 2010). *See* Ex-1009-Hensen-Provisional, ¶36 (“Additional details regarding various capabilities and function of the processing circuitry 700, including processing and audio playback, as well as the ear-mounted device 100 in general, may be found in [Hensen-Parent], the content of which is incorporated herein by reference in its entirety, except to the extent

disclosure therein is inconsistent with disclosure herein.”). Hensen-Parent, in turn, describes the same wireless earpiece system as the one in Hensen-Patent. *Compare* Ex-1008-Hensen-Parent, Figures 1-4, 4:36-6:19, 7:40-8:9 *with* Ex-1003-Hensen-Patent, Figures 1-4, 4:55-6:41, 7:65-8:34 (both documents include the same description of wireless earpiece system 20, including earpieces 30 and 60 and remote control device 51). Thus, by incorporating by reference Hansen-Parent and describing capabilities that build upon the system of Hensen-Parent, Hensen-Provisional also demonstrates its compatibility with the system of Hensen-Patent. Moreover, whereas Hensen-Provisional discloses details about the pulse oximetry and activity monitoring capabilities, Hensen-Patent provides a more comprehensive description of the remaining components of the wireless earpiece system (e.g., earpieces 30 and 60 and remote control device 51).

87. In addition, it would have been obvious to combine Hensen-Provisional’s pulse oximetry capabilities with Hensen-Patent’s wireless earpiece system, particularly given that Hensen-Provisional expressly discloses this combination (as I explained above). A POSITA would have combined these teachings with a reasonable expectation of success because Hensen-Patent discloses a wireless earpiece system, and Hensen-Provisional discloses additional capabilities of such a system (e.g., the ability to carry out pulse oximetry measurements in an otherwise similar system).

88. In fact, Hensen-Video demonstrates a real-world implementation of a system that includes wireless earpieces having physiological sensors (e.g., integrated pulse oximeters). For example, Hensen-Video demonstrates an onboard pulse oximeter that concurrently measures two independent physiological quantities, heart rate and oxygen saturation. Ex-1004-Hensen-Video, 0:09-0:19 (“Right now I’m actually listening to some music and I’ve also engaged the pulse oximetry”), 0:48-1:09 (“I’m going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%”). More generally, it was well-known that pulse oximeters can measure physiological quantities like heart rate and oxygen saturation based on detecting light signals that pass through a user’s flesh. *See, e.g.*, Ex-1024 (USP 9,392,946), 7:21-60 (heart rate can be measured in relatively simple, robust manner based on time-varying fluctuations in a light signal, e.g.: “When a blood vessel expands, it allows more blood to flow into the vessel, which results in the amount of blood present in a given region of the person’s flesh fluctuating in rhythm with the person’s heart rate. This, in turn, results in fluctuations in the amount of light from the light source that is emanated back out of the flesh. The heart rate may then be determined by measuring the amount of light that emanates back out of the person’s flesh via the above-described diffusion mechanism”); Ex-1025 (USP 8,818,476), 7:9-20 (oxygen saturation is typically measured using a substantially more complex, calibration-intensive calculation, e.g.: “An example of a sensor

assembly 10 containing at least one emitter 16 and at least one detector 18 may also contain an encoder 100 which may be capable of providing signals indicative of the wavelength(s) of light source 16 to allow the oximeter to select appropriate calibration coefficients for calculating oxygen saturation.”).

3. Claim 3: The system of claim 2 wherein the software application provides for tracking one or more physical activities using the physiological sensor.

89. As I explained for Element [1B] and Claim 2, Hensen-Patent in combination with Hensen-Video teaches a software application and a physiological sensor (e.g., a pulse oximeter). The combination also discloses that the software application provides for tracking one or more physical activities using the physiological sensor.

(i) Hensen-Patent

90. As I explained for Element [1B], Hensen-Patent teaches a remote control device that has the ability to display information received from the earpieces. Ex-1003-Hensen-Patent, 8:24-34 (“The remote control unit 51 also illustratively includes remote control unit input devices 52, for example, push buttons, that correspond to the commands. The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining. The remote control unit 51 may advantageously

send commands corresponding to ones of the input devices 37. Of course, the remote control unit 51 may send other commands and may display other information.”); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42.

91. The information displayed on the remote control device can include information associated with one or more physical activities received from the physiological sensor (e.g., the pulse oximeter disclosed by Hensen-Provisional). For example, as I explained for Claim 2, pulse oximetry data from the pulse oximeter can be transmitted to the remote control device. Ex-1009-Hensen-Provisional, ¶42 (“Each of the pulse, oxygen saturation, and error signal as may be determined/generated by the processing circuitry 700 may be transmittable by the processing circuitry 700 to an electronic device as described hereinabove, Any method of transmission is contemplated and included within the scope of the invention, including wireless transmission according to wireless transmission standards as are known in the industry, including, but not limited to, Bluetooth, Zigbee, Wi-Fi, and any other IEEE 802.XX standard. The processing circuitry 700 may comprise electronic components necessary to enable such communication.”).

92. Hensen-Patent also teaches that users are expected to wear the wireless earpiece system (and thus transmit pulse oximetry data to the remote control device) while participating in various types of physical activities, including running, cycling, and swimming. Ex-1009-Hensen-Provisional, ¶14 (“The ear-mounted device may

be removably attached to an ear of the user so as to resist unintended detachment during periods of activity by the user, such as any type of exercise or athletic endeavor, including, but not limited to, running, jogging, stretching, acrobatics, aerobics, cycling, swimming, and any other type of high-impact, low-impact, or no impact exercise as is known”); *see also* Ex-1003-Hensen-Patent, 13:6-16 (“Moreover, the stereo audio headphone units 30, 60 advantageously are wireless and have a relatively low profile behind the ear. This increases user comfort in wearing the stereo audio headphones, and may be particularly advantageous in activities involving wearing of a helmet and in activities involving a range of body movements, for example. More particularly, the wireless operation of the stereo audio headphones may be particularly useful during a workout or during a run, for example, on a treadmill. As will be appreciated by those skilled in the art, interference with movement, from wires, for example, is reduced.”).

(ii) Hensen-Video

93. Hensen-Video likewise teaches that the remote control device displays information (e.g., pulse oximetry data) received from the earpieces while the user is engaging in a physical activity. Hensen-Video further teaches that the remote control device includes a software application that provides for tracking the one or more physical activities using the physiological sensor.

94. For example, a screenshot from Hensen-Video is shown below.



Ex-1004-Hensen-Video, 0:09-0:19. In his narration, Dr. Hensen explains that the earpieces (red arrows) include a physiological sensor (e.g., a pulse oximeter) and send pulse oximetry data to the remote control device (purple arrow). *Id.* (“I’m currently wearing both the right and left units. I’ve already turned them on. I’ve paired them with each other and also paired with the source device, in this case, a smartphone. I’m going to go ahead and show a few functions that are currently running. Right now I’m actually listening to some music and I’ve also engaged the pulse oximetry”).

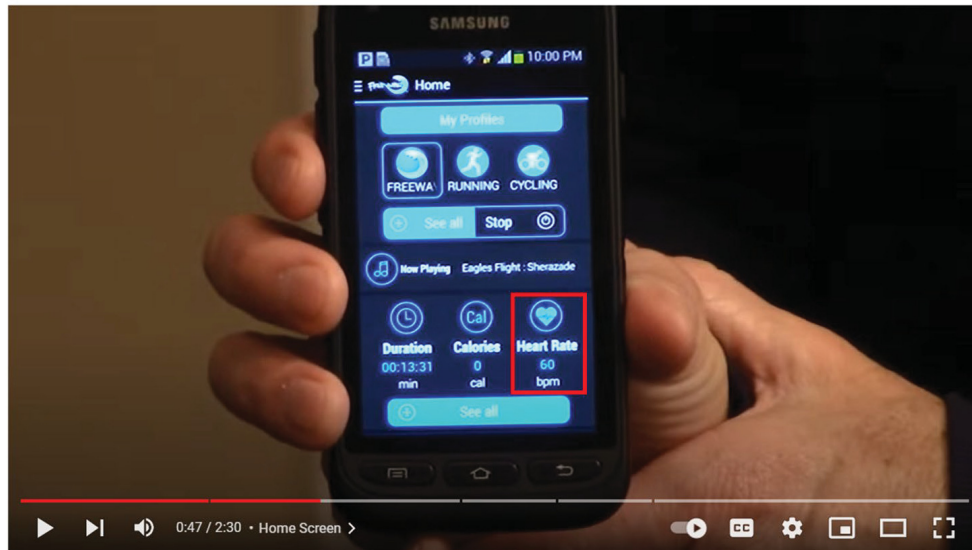
95. A screenshot from Hensen-Video demonstrating the home screen display is shown below.



Ex-1004-Hensen-Video, 0:38. The screenshot shows illustrative physical activities (e.g., running and cycling) that a user can track using the above-described pulse oximetry capabilities (*see* Section IX.A.2).

96. The FreeWavz software interface provides for tracking the user's physical activity using data from the pulse oximeter. The tracking can be performed in real time (e.g., by displaying the user's instantaneous heart rate and blood oxygen saturation) or over time (e.g., by displaying a waveform that shows changes in the

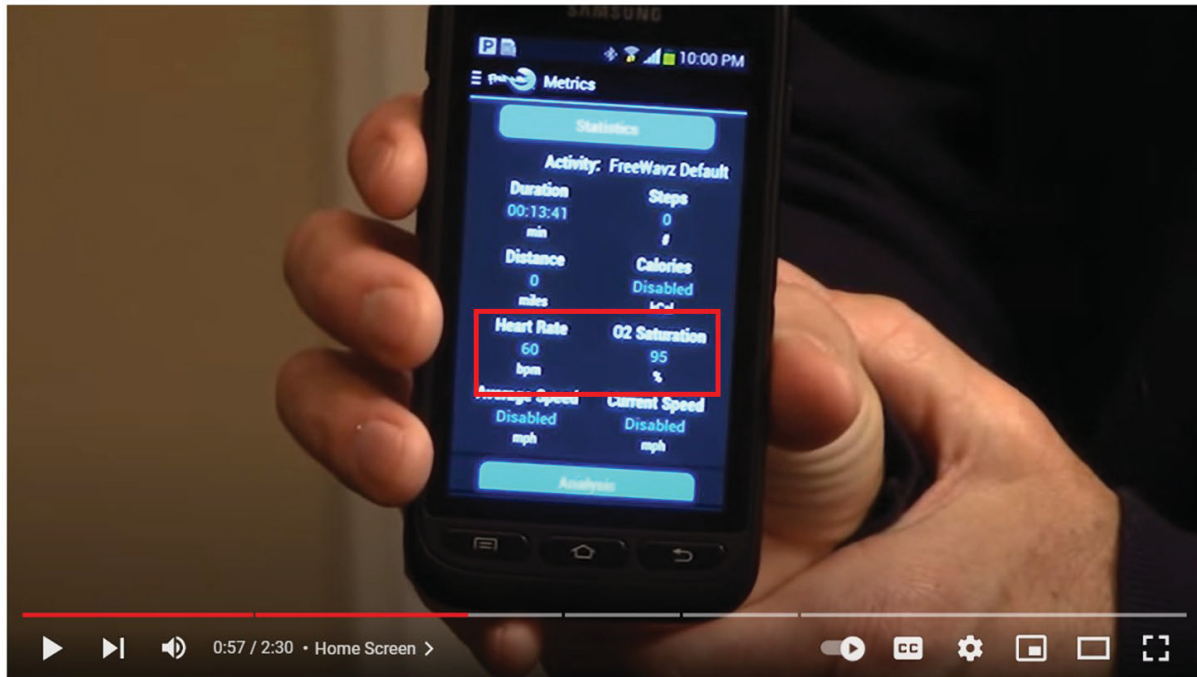
user's heart rate over time). For example, the screen shot below shows that the user's instantaneous heart rate is 60 beats per minute (BPM).²



Ex-1004-Hensen-Video, 0:43-0:48 (“You can also see down below here is my heart rate at 60”).

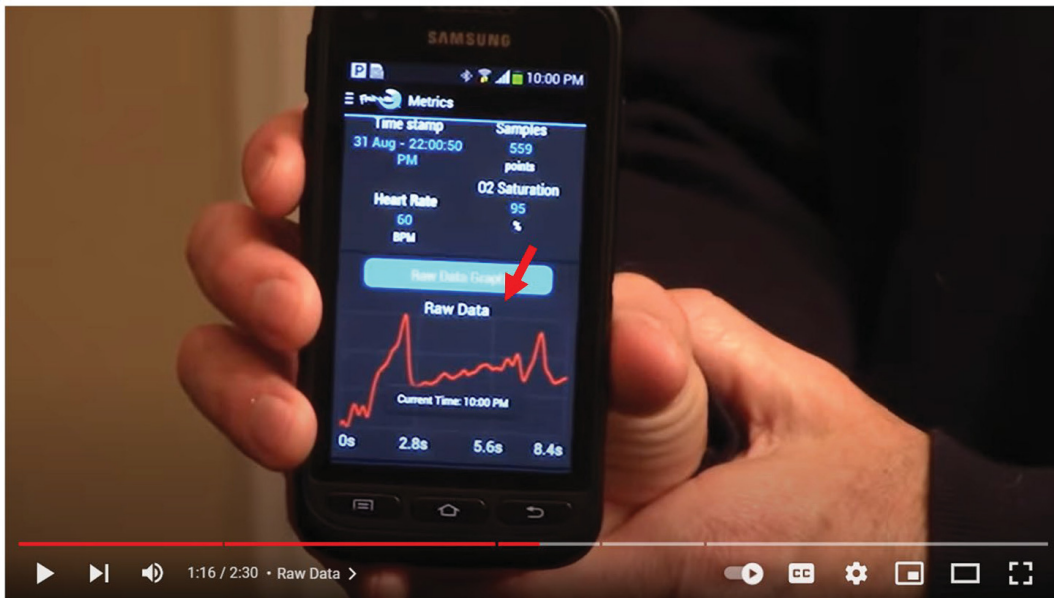
² During examination of the '385 patent, the applicant identified measuring heart rate as an example of tracking a physical activity that satisfies claim 3. Ex-1011-FH [PDF229] (Appeal Brief at 8) (citing Specification 9:7-10 as supporting claim 3: “Various information associated with this activity is also shown. This may include heart rate 132 as measured by one or more of the ear pieces such as through use of a pulse oximeter, steps 134, as measured by one or more of the ear pieces such as through use of an inertial sensor, and duration 136”).

97. Similarly, the screenshot below shows that the user's instantaneous blood oxygen saturation is 95%.



Ex-1004-Hensen-Video, 0:48-1:09 (“I’m going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%. And that’s kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.”)

98. Moreover, the screenshot below shows that the FreeWavz software application tracks physical activity over time by using a waveform representation of the pulse oximetry data.



Ex-1004-Hensen-Video, 1:09-1:24 (“I’m going to demonstrate the raw data that has been obtained. If you can see that red line, that is our waveform. That is where our raw data is being obtained from -- that is, the heart rate and the oxygen saturation.”).

99. As I explained for element [1B], A POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success. Furthermore, Hensen-Patent explicitly states that its remote control device 51 is used to display information received from wireless earpieces 30 and 60, and Hensen-Video provides mechanisms for doing so when remote control device 51 is implemented as a software application on a smartphone, a computing device.

4. Claim 4: The system of claim 3 wherein the physical activities are selected from a set consisting of running, biking, and swimming.

100. As I explained for Claim 3, Hensen-Patent in combination with Hensen-Video teaches a software application for tracking physical activities including running, biking (i.e., cycling), and swimming. Ex-1009-Hensen-Provisional, ¶14 (“The ear-mounted device may be removably attached to an ear of the user so as to resist unintended detachment during periods of activity by the user, such as any type of exercise or athletic endeavor, including, but not limited to, running, jogging, stretching, acrobatics, aerobics, cycling, swimming, and any other type of high-impact, low-impact, or no impact exercise as is known”).

101. An annotated screenshot of Hensen-Video’s software application is reproduced below.



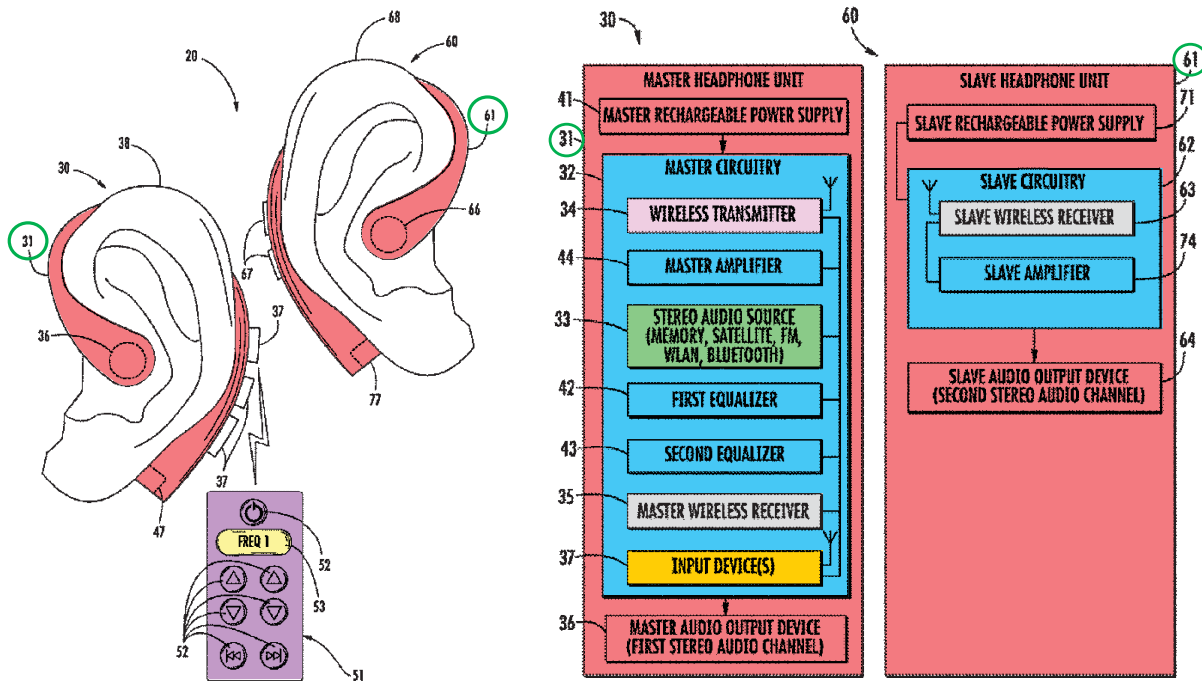
Ex-1004-Hensen-Video, 0:38. As shown above, the software application provides a user interface for the user to select among the activities to be tracked (in the example shown above, running and cycling). *Id.*

102. To the extent the Patent Owner may contend that the activities shown above do not form a closed set “consisting of” running, biking, and swimming, the claimed set of activities would have been obvious to a POSITA. The implementation of the software application does not depend on the exact list of activities that are displayed; rather, the designer and/or user is free to choose which activities are displayed as a matter of design choice. Modifying the software to display a particular set of activities would have been well within the knowledge and skill of a POSITA. In fact, a POSITA would have had a specific motivation to modify the software to display the three claimed activities (running, biking, and swimming) because they are the three elements of a triathlon, a sport that has been well-known since the early 1970s and part of the Olympics since before the claimed priority date of the ’385 patent. Ex-1018 (“Triathlon was invented in the early 1970s by the San Diego Track Club as an alternative workout to the rigours of track training. The club's first event consisted of a 10km run, an 8km cycle and a 500m swim. Over the next decade, triathlon’s popularity continued to build, and it soon gained worldwide recognition.... Triathlon made its Olympic full medal debut at the 2000 Sydney Games. This helped the sport to become even more popular.”).

103. Moreover, a POSITA would have modified Hensen-Video's software to track activities selected from the closed set of running, biking, and swimming with a reasonable expectation of success. As shown in the above screen shot, Hensen-Video's software application already provides the ability to select among running and biking. The addition of just one more activity (swimming) would have been straightforward to implement and a POSITA would have had no issue doing so successfully.

5. Claim 9: The system of claim 1 wherein the at least one wireless ear piece comprises onboard storage for storing audio files.

104. As shown in Figures 1 and 2 below, Hensen-Patent teaches wireless earpieces (e.g., headphone units 30 and 60 (red)) comprising onboard storage (e.g., memory within stereo audio source 33 (light green)) for storing audio files (e.g., MP3 files). Ex-1003-Hensen-Patent, 4:66-5:4 ("The master circuitry includes a stereo audio source 33 and a wireless transmitter 34 coupled thereto. The stereo audio source 33 may be a memory, for example, and may store stereo audio data. The memory may be fixed or may be removable, for example, a secure digital (SD) memory card. Other types of memory, may be used."), 5:5-8 ("The stereo audio data that may be stored in a memory or provided by the stereo audio source may be mpeg layer 3 (mp3) encoded data [("audio files")], for example. Other types of stereo audio data or other data may be stored in the memory.").



Ex-1003-Hensen-Patent, Figure 1 (left) and Figure 2 (right).

105. In fact, Hensen-Patent discloses a variety of arrangements for storing audio files, including:

- storing audio files in onboard storage of the earpieces (Ex-1003-Hensen-Patent, 4:66-5:4 (“The master circuitry includes a stereo audio source 33 and a wireless transmitter 34 coupled thereto. The stereo audio source 33 may be a memory, for example, and may store stereo audio data. The memory may be fixed or may be removable, for example, a secure digital (SD) memory card. Other types of memory, may be used.”), 5:5-8)
- wirelessly receiving audio files from an external source (*id.*, 5:9-19 (“The stereo audio source 33 may be a stereo audio wireless receiver.... [T]he

stereo audio wireless receiver may be a Bluetooth or wireless local area network (WLAN) receiver to wirelessly receive stereo audio therefrom, for example, as may be transmitted from a mobile wireless communications device (i.e. cellular telephone), or over an Internet transmission.”))

- hybrid approaches that use both onboard storage and wireless receiver to access audio files (*id.*, 5:19-24 (“The stereo audio wireless receiver may be another type of wireless receiver, a combination of wireless receivers, and the stereo audio source 33 may be a combination of a stereo audio wireless receiver and/or memory to provide stereo audio from more than one stereo audio source”)).

Hensen-Patent therefore discloses storing audio files using onboard storage of the wireless earpieces as an alternative to (or in addition to) wirelessly receiving audio files from external sources.

6. Claim 10: The system of claim 1 wherein the at least one wireless ear piece is configured to store at least one playlist of audio files.

106. As I explained for Claim 9, Hensen-Patent teaches wireless earpieces (e.g., headphone units 30 and 60) that store audio files (e.g., MP3 files). *See, e.g.*, Ex-1003-Hensen-Patent, 4:66-5:4 (“The master circuitry includes a stereo audio source 33 and a wireless transmitter 34 coupled thereto. The stereo audio source 33 may be a memory, for example, and may store stereo audio data. The memory may

be fixed or may be removable, for example, a secure digital (SD) memory card. Other types of memory, may be used."), 5:5-8 ("The stereo audio data that may be stored in a memory or provided by the stereo audio source may be mpeg layer 3 (mp3) encoded data [{"audio files"}], for example. Other types of stereo audio data or other data may be stored in the memory."). Hensen-Patent also teaches the additional limitations of claim 10, namely, that the stored audio files include at least one playlist of audio files. For example, Hensen-Patent teaches that the wireless earpiece has an input device, such as a push button, to "skip" to another song. *Id.*, 5:37-44 ("Input devices 37 are illustratively carried by the master housing 31. The input devices 37 may be push buttons and may be coupled to the master circuitry 32. The input devices 37 may be for adjusting volume, and stereo audio source selection. For example, if the stereo audio source is a memory having stereo audio (music) stored thereon, a selected one of the input devices 37 may be for skipping to another song, or fast-forwarding through a song."), 8:17-20 ("For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 may send commands for skipping to another song, or fast-forwarding through a song."). Because the next song can be selected using a push button, the next song is thus preselected, meaning there is a preselected ordered list of songs, i.e., a playlist, stored on the wireless earpiece.

7. Claim 11: The system of claim 1 wherein the software application provides for connecting the at least one wireless ear piece with the computing device.

107. As shown in the annotated screenshot below, Hensen-Video teaches a software application that provides for connecting (e.g., pairing) the at least one wireless earpiece (e.g., right and left headphone units (red arrows)) with the computing device (e.g., smartphone computing device (purple arrows)).



Ex-1004-Hensen-Video, 0:09-0:19 (“I’m currently wearing both the right and left units. I’ve already turned them on. I’ve paired them with each other and also paired with the source device, in this case, a smartphone.”). More specifically, on a smartphone (e.g., Android phone) like the one demonstrated in Hensen-Video, apps connect to peripheral devices (such as wireless earpieces) via the smartphone’s operating system, which provides application programming interfaces (APIs) (e.g., a Bluetooth API) that the app invokes when connecting to

the peripheral devices. Accordingly, a POSITA would have understood Hensen-Video's software application to provide for connecting the earpieces to the smartphone computing device using such an API.

108. As I explained for Element [1B], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success. In addition, Hensen-Patent teaches connecting wireless earpieces with a remote control device, (*see, e.g.*, Ex-1003-Hensen-Patent, 5:9-24, 7:65-8:7, Claim 14; Ex-1009-Hensen-Provisional, ¶¶14, 35), and Hensen-Video provides mechanisms for doing so when the remote control device includes a software application on a smartphone computing device.

8. Claim 12: The system of claim 11 wherein the computing device is a mobile device.

109. As I explained for Element [1B] (*see* Section IX.A.1(c)(iii)), Hensen-Patent teaches that a mobile device, such as a smart phone, can be used to implement the remote computing device of its wireless earpiece system. Ex-1009-Hensen-Provisional, ¶35 (“The communication device [within the wireless earpieces] may be configured to communicate with a remote computerized device, either over a wired connection or a wireless connection. Such remote computerized devices may include... smart phones.”). In addition, as shown in the screenshot below, Hensen-

Video discloses a that the computing device is a mobile device (e.g., a smartphone (purple arrow)).



Ex-1004-Hensen-Video, 0:09-0:19 (“I’m currently wearing both the right and left units. I’ve already turned them on. I’ve paired them with each other and also paired with the source device, in this case, a smartphone.”). As I explained above for Element [1B] and Claim 11, a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success.

9. Claim 13

(a) [13Preamble] A method for controlling a set of wireless ear pieces, the method comprising:

110. As I explained for Elements [1Preamble], and further explained below for Elements [13A]-[13E], Hensen-Patent discloses a method for controlling a set of wireless earpieces (stereo headphone units 30 and 60).

- (b) [13A] providing a software application for controlling the set of wireless ear pieces, the software application adapted to execute on a computing device;

111. As I explained for Element [1B], Hensen-Patent in combination with Hensen-Video teaches providing a software application for controlling the set of wireless earpieces (headphone units 30 and 60), the software application adapted to execute on a computing device (smartphone computing device).

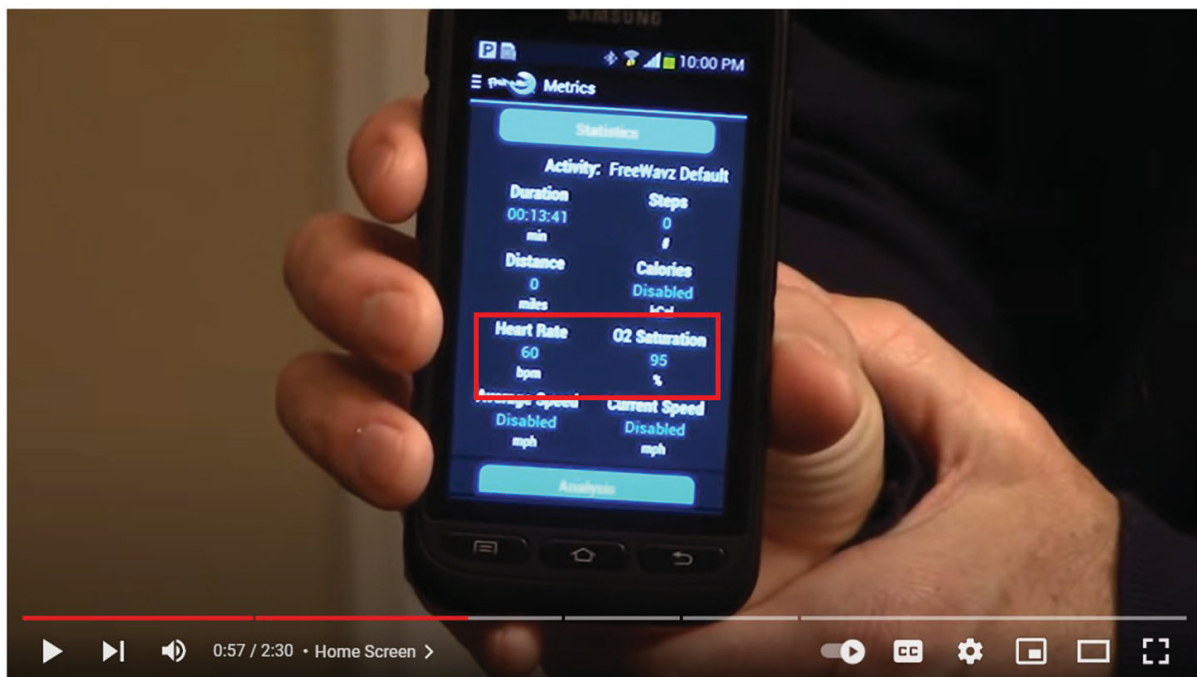
- (c) [13B] using the software application on the computing device to display one or more screen displays on a display of the computing device and to receive input from the user into the mobile device;

112. As I explained for Element [1C], Hensen-Patent in combination with Hensen-Video teaches using the software application on the computing device (smartphone computing device) to display one or more screen displays (e.g., a home screen display) on a display (smartphone display) of the computing device. Hensen-Patent in combination with Hensen-Video also teaches the limitations of using the software application to receive input from the user into the mobile device.

113. Referring first to Hensen-Patent, Hensen-Patent teaches that remote control device 51 receives input from the user. Ex-1003-Hensen-Patent, 8:24-34 (“The remote control unit 51 also illustratively includes remote control unit input devices 52, for example, push buttons, that correspond to the commands.... The remote control unit 51 may advantageously send commands corresponding to ones

of the input devices 37. Of course, the remote control unit 51 may send other commands and may display other information.”); *see also id.*, 8:14-23; Ex-1009-Hensen-Provisional, ¶35.

114. Referring next to Hensen-Video, Hensen-Video teaches a software application on a remote control device (e.g., a [smartphone computing device](#)), where the software application receives an input from the user into the remote control device. A screenshot from Hensen-Video is reproduced below.



Ex-1004-Hensen-Video, 0:48-1:09. The video shows the user (in this instance, Dr. Hensen) is using his finger to provide an input to the smartphone device to scroll through the display screens and show data (e.g., pulse oximetry data) associated with the wireless earpieces. *Id.* (“I’m going to go ahead and show all, and you can

see not only my heart rate but my oxygen saturation at 95%. And that's kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.”).

115. As I explained for Element [1B], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success. Furthermore, Hensen-Patent teaches that remote control device 51 receives input from the user, and Hensen-Video provides mechanisms for doing so when remote control device 51 includes a software application on a smartphone computing device.

(d) [13C] wherein at least one of the one or more screen displays display a visual representation of the set of wireless ear pieces;

116. As I explained for Element [1E], Hensen-Patent in combination with Hensen-Video teaches that at least one of the one or more screen displays display a visual representation of the set of wireless earpieces.

(e) [13D] communicating data associated with the input between the software application and at least one of the wireless ear pieces;

117. As I explained above for Element [1D], Hensen-Patent in combination with Hensen-Video teaches communicating data associated with the input between the software application and at least one of the wireless earpieces. For example, Hensen-Patent’s remote control device sends data (e.g., commands) associated with

the user's input to the earpieces. Ex-1003-Hensen-Patent, 8:14-23 ("The remote control unit 51 is configured to transmit commands, for example, to the master wireless receiver 35 [of headphone unit 30]. Commands that may be transmitted include volume, and stereo audio source selection. For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 [sic: 51] may send commands for skipping to another song, or fast-forwarding through a song. The remote control unit 43 [sic: 51] may also send commands relating to the independent selection of the frequency equalization for the first and second stereo audio channels."), 8:24-34; *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42.

118. As I further explained for Element [1D], Hensen-Patent in combination with Hensen-Video teaches that the remote control device can include a software application running on a smartphone device. When the teachings are combined in this manner, the data being communicated is associated with a software application running on a smartphone device. As I explained for Elements [1B] and [1D], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success.

(f) [13E] performing an action using at least one of the wireless ear pieces in response to receiving the data.

119. As I explained for Element [13D], Hensen-Patent teaches performing an action (e.g., volume selection, audio source selection, skipping to another song,

or fast-forwarding through a song) using the wireless earpieces (e.g., headphone units 30 and 60) in response to receiving the data. Ex-1003-Hensen-Patent, 8:14-23 (“The remote control unit 51 is configured to transmit commands, for example, to the master wireless receiver 35 [of headphone unit 30]. Commands that may be transmitted include volume, and stereo audio source selection. For example, if the stereo audio source 33 is a memory having music stored thereon, the remote controller 43 [sic: 51] may send commands for skipping to another song, or fast-forwarding through a song. The remote control unit 43 [sic: 51] may also send commands relating to the independent selection of the frequency equalization for the first and second stereo audio channels.”), 8:24-34; *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42.

10. Claim 14

(a) [14Preamble] A method for communicating data from a set of wireless ear pieces, the method comprising:

120. As I explained for Elements [1Preamble] and [13Preamble], and as further explained below for Elements [14A]-[14E], Hensen-Patent teaches a method for controlling a set of wireless earpieces (stereo headphone units 30 and 60).

- (b) [14A] providing a software application for communicating with the set of wireless ear pieces, the software application adapted to execute on a computing device;

121. As I explained for Elements [1B] and [13A], Hensen-Patent in combination with Hensen-Video teaches providing a software application for controlling the set of wireless earpieces (headphone units 30 and 60), the software application adapted to execute on a computing device (smartphone computing device).

- (c) [14B] using the software application on the computing device to display one or more screen displays on a display of the computing device,

122. As I explained for Elements [1C] and [13B], Hensen-Patent in combination with Hensen-Video teaches using the software application on the computing device (smartphone computing device) to display one or more screen displays (e.g., a home screen display) on a display (smartphone display) of the computing device.

- (d) [14C] wherein at least one of the one or more screen displays display a visual representation of the set of wireless ear pieces;

123. As I explained for Elements [1E] and [13C], Hensen-Patent in combination with Hensen-Video teaches that at least one of the one or more screen displays display a visual representation of the set of wireless earpieces.

(e) [14D] communicating data received from one or more of the wireless ear pieces to the computing device; and

124. As I explained for Element [1D], Hensen-Patent in combination with Hensen-Video discloses communicating data received from one or more of the wireless earpieces to the computing device. For example, Hensen-Patent's remote control device that receives data (e.g., volume, battery power remaining, or pulse oximetry data) transmitted wirelessly from the earpieces to the remote control device. Ex-1003-Hensen-Patent, 8:24-34 ("The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining.... Of course, the remote control unit 51 may send other commands and may display other information."); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14 ("An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the ear-mounted device may be configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device."), 35, 42.

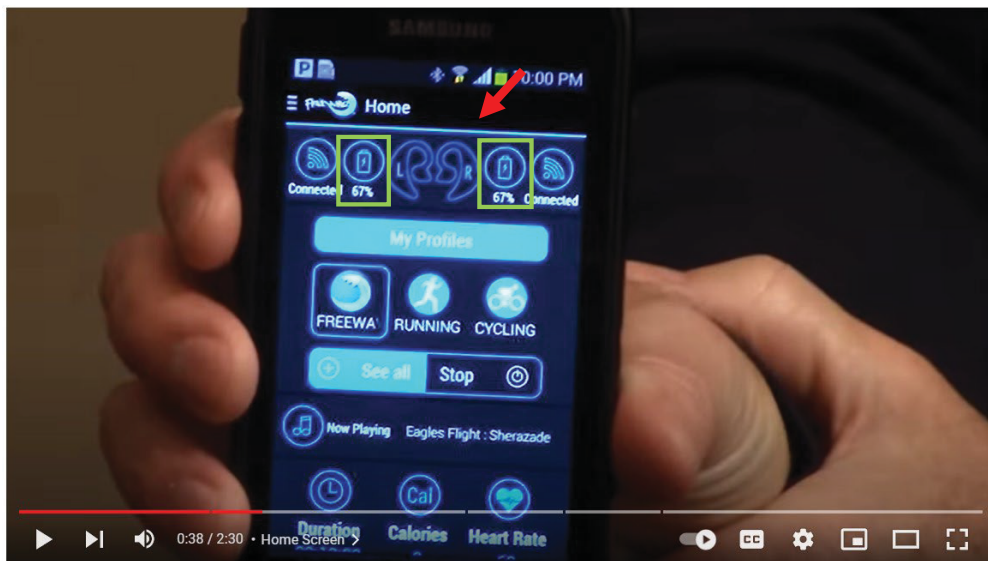
125. As I further explained for Element [1D], Hensen-Patent in combination with Hensen-Video teaches that the remote control device can include a software application running on a smartphone computing device. When the teachings are combined in this manner, the data is communicated to a smartphone computing device. As I explained for Elements [1B] and [1D], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success.

(f) [14E] updating the screen displays on the display of the computing device using the data.

126. As I explained for Elements [1D] and [14D], Hensen-Patent in combination with Hensen-Video teaches updating the screen displays on the display of the computing device using the data. For example, the display of Hensen-Patent's remote control device is updated to display data (e.g., volume, battery power remaining, or pulse oximetry data) received from the earpieces. Ex-1003-Hensen-Patent, 8:24-34 ("The remote control unit 51 also includes a display 53 that may display information about the stereo audio source 33, for example, a song title or artist, or information about the stereo audio headphones, for example, volume and/or battery power remaining.... Of course, the remote control unit 51 may send other commands and may display other information."); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42.

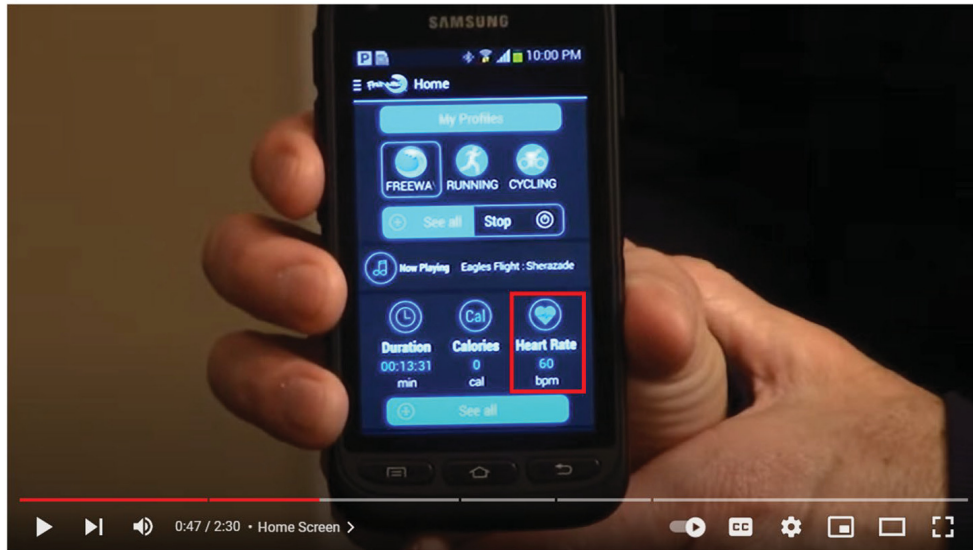
127. As I further explained for Element [1D], Hensen-Patent in combination with Hensen-Video teaches that the remote control device can include a software application running on a smartphone computing device. When the teachings are combined in this manner, the software application updates screen displays on the smartphone display using data received from wireless earpieces.

128. A screenshot of Hensen-Video's home screen display is shown below.



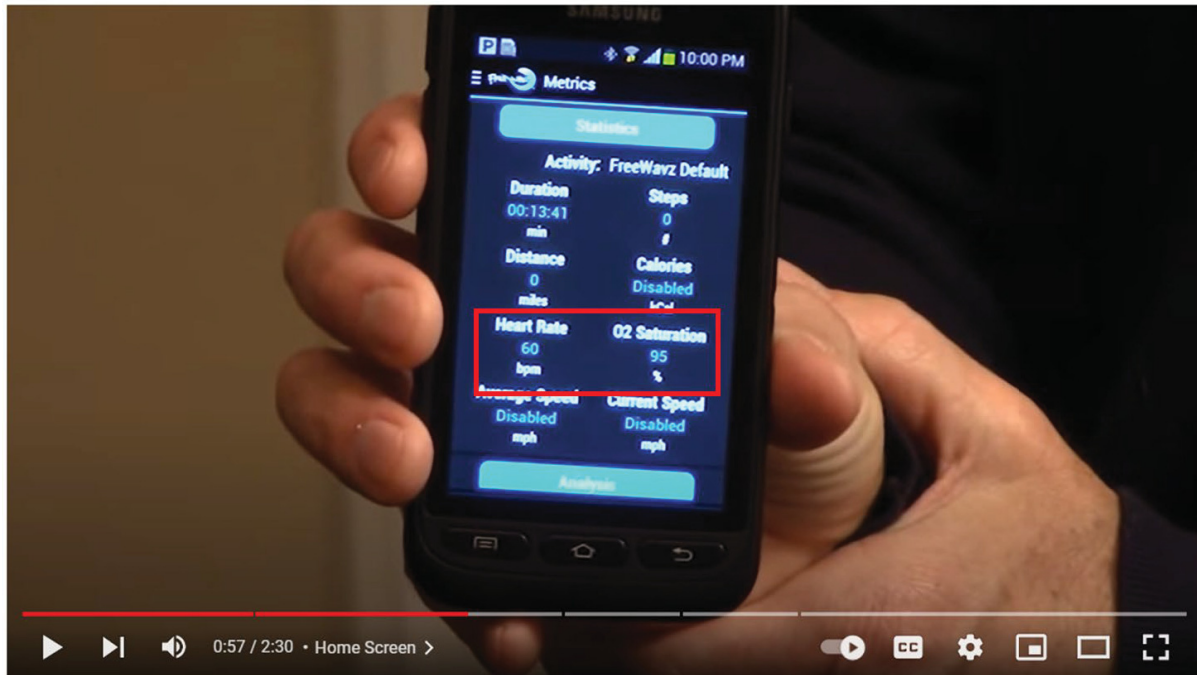
Ex-1004-Hensen-Video, 0:32-0:38. The screenshot shows that the display is updated based on data from the wireless earpieces that indicates the remaining battery life. *Id.* (“I want to show you this home screen. I'm going to hold it real still. Now at the top you're going to see each unit and the battery life.”).

129. Another screenshot of Hensen-Video's home screen display shown below.



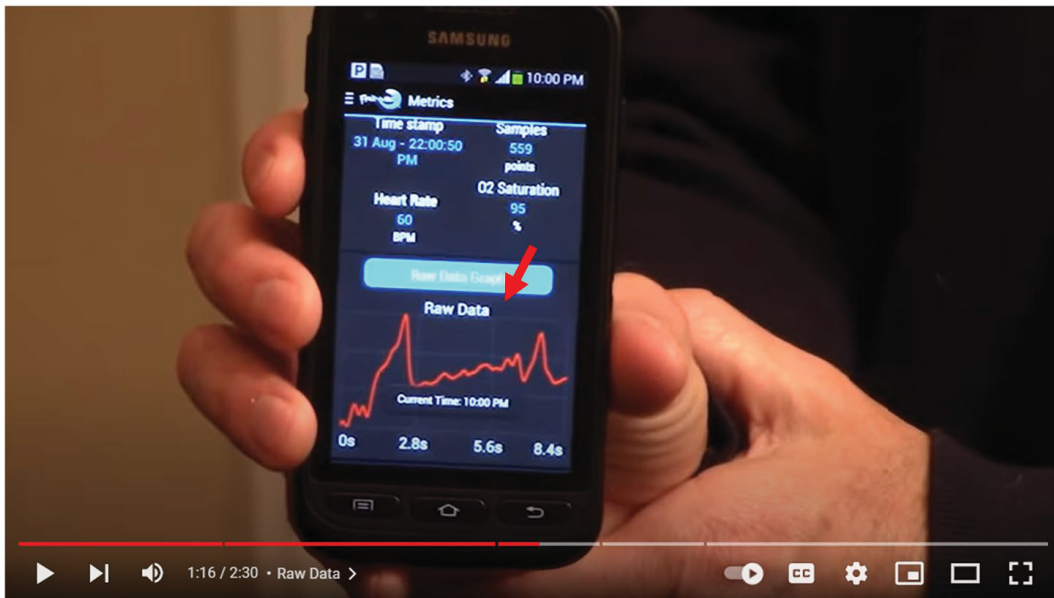
Ex-1004-Hensen-Video, 0:43-0:48. In this case, the display is updated using data from the wireless earpieces associated with the user's heart rate. *Id.* ("You can also see down below here is my heart rate at 60").

130. A third screenshot of Hensen-Video's software application is shown below, this time illustrating the "metrics" screen display.



Ex-1004-Hensen-Video, 0:48-1:09. The screenshot shows that the display is updated using data from the wireless earpieces indicating the user's heart rate and oxygen saturation. *Id.* ("I'm going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%. And that's kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.").

131. Another screenshot from the software application is shown below.



Ex-1004-Hensen-Video, 1:09-1:24. As shown above, the display that is updated using data from the wireless earpieces that includes raw pulse oximetry data plotted as a waveform. *Id.* (“I’m going to demonstrate the raw data that has been obtained. If you can see that red line, that is our waveform. That is where our raw data is being obtained from -- that is, the heart rate and the oxygen saturation.”).

132. As I explained for Elements [1B] and [1D], a POSITA would have been motivated to combine Hensen-Patent and Hensen-Video with a reasonable expectation of success. Furthermore, Hensen-Patent teaches that a remote control device displays data from wireless earpieces, and Hensen-Video provides mechanisms for doing so when the remote control device includes a software application running on a smartphone device.

11. Claim 15: The method of claim 14 wherein the data comprises physiological data.

133. As I explained for Claims 2-4, Hensen-Patent in combination with Hensen-Video teaches that the data from the wireless earpieces comprises physiological data (e.g., pulse oximetry data, such as heart rate and oxygen saturation). Ex-1009-Hensen-Provisional, ¶14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear-mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the ear-mounted device may be configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device.”); Ex-1004-Hensen-Video, 0:09-0:19 (“Right now I'm actually listening to some music and I've also engaged the pulse oximetry”), 0:48-1:09 (“I'm going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%. And that's kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.”).

12. Claim 16: The method of claim 15 wherein the physiological data is heart rate data.

134. As I explained for Claims 14 and 15, Hensen-Patent discloses that the physiological data is heart rate (or pulse) data. Ex-1009-Hensen-Provisional, ¶14 (“An embodiment of the invention, as shown and described by the various figures and accompanying text, provides an ear- mounted device comprising integrated pulse oximetry capabilities. The ear-mounted device may be configured to measure at least one of the pulse and the oxygen saturation of a user while simultaneously providing acoustic functionality to the user. Furthermore, the ear-mounted device may be configured to be wirelessly connected to an electronic device so as to provide the pulse oximetry information generated thereby to the electronic device.”); Ex-1004-Hensen-Video, 0:09-0:19 (“Right now I'm actually listening to some music and I've also engaged the pulse oximetry”), 0:48-1:09 (“I'm going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%. And that's kind of consistently where I run as far as my heart rate is concerned. Oxygen usually is normal between 95 and 100 percent.”).

B. Ground 2

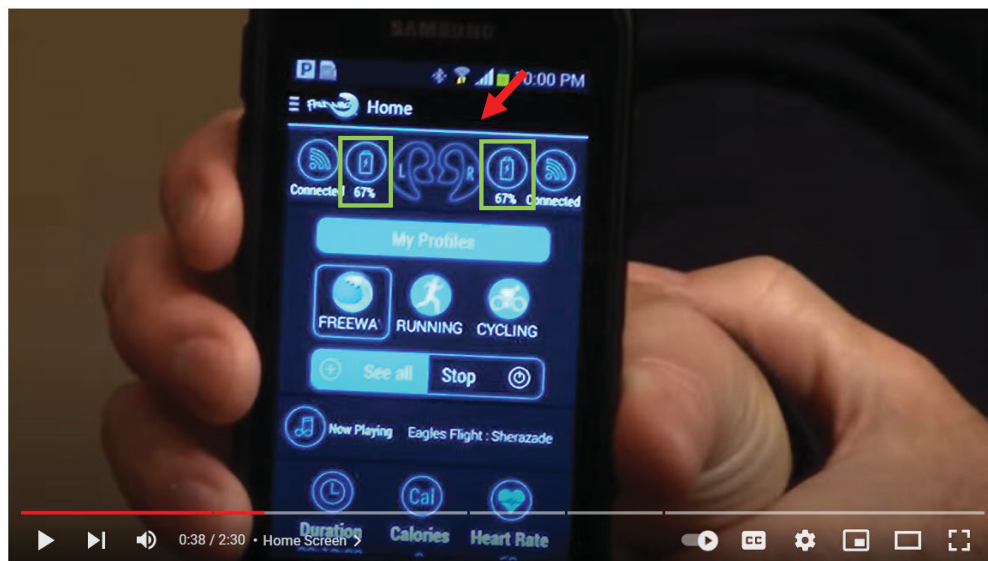
135. As explained in further detail below, claims 5-7 would have been obvious over the combined teachings of Hensen-Patent, Hensen-Video, and LG-Manual. As I explained in Section IX.A.1 (Ground 1), the combination of Hensen-

Patent and Hensen-Video teach each of the limitations of claim 1. Meanwhile, the combination of Hensen-Patent, Hensen-Video, and LG-Manual teach the additional features of claims 5-7.

136. LG-Manual is a user manual for the LG FR74 Heart Rate Earphones product. The manual was posted on LG's website on May 14, 2014, under the product page for the FR74 product. Ex-1019. An earlier version of the manual was also submitted to the FCC and published through the FCC website on February 11, 2014, and it contains the same substantive teachings as those discussed below. Ex-1020; Ex-1021.

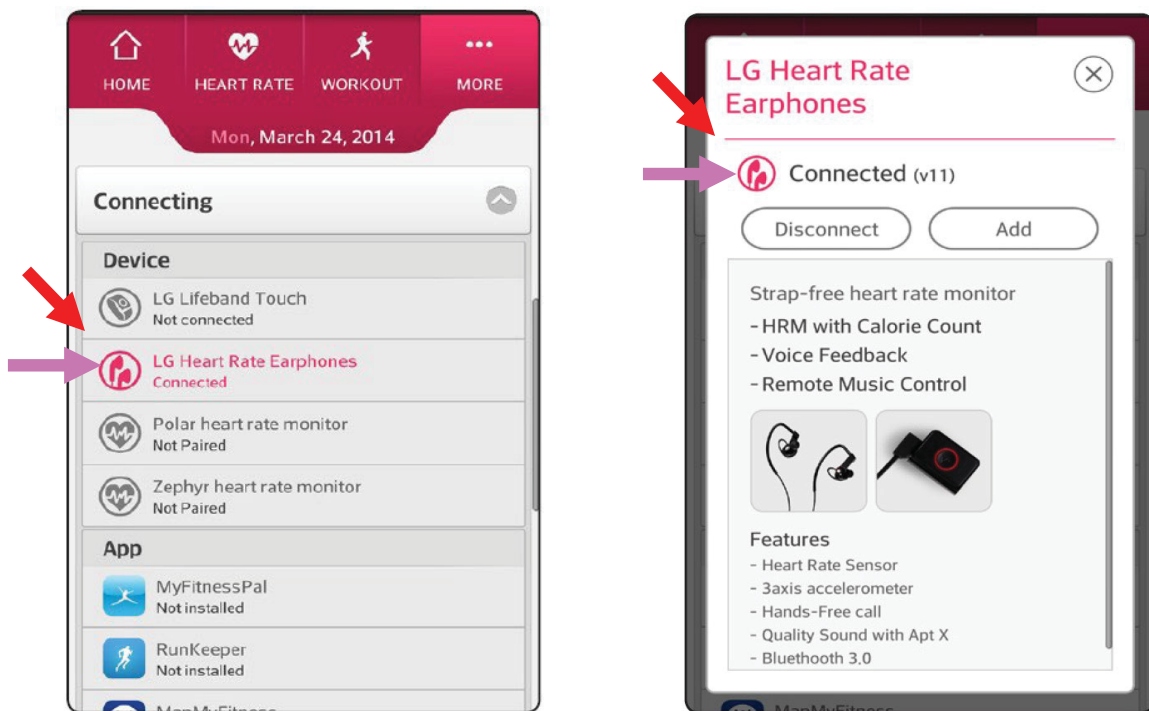
1. Claim 5: The system of claim 1 wherein the representation visual representation includes lighting of the at least one wireless ear piece

137. As I explained for Element [1E] and [1F], Hensen-Video teaches a visual representation of the earpieces, as shown in the screenshot below.



Ex-1004-Hensen-Video, 0:32-0:38. The above visual representation of the earpieces indicates the remaining battery life (green) of each of the earpieces (red arrow). *Id.* (“I want to show you this home screen. I'm going to hold it real still. Now at the top you're going to see each unit and the battery life.”).

138. LG-Manual includes similar teachings to those of Hensen-Video, as shown in the diagram below.

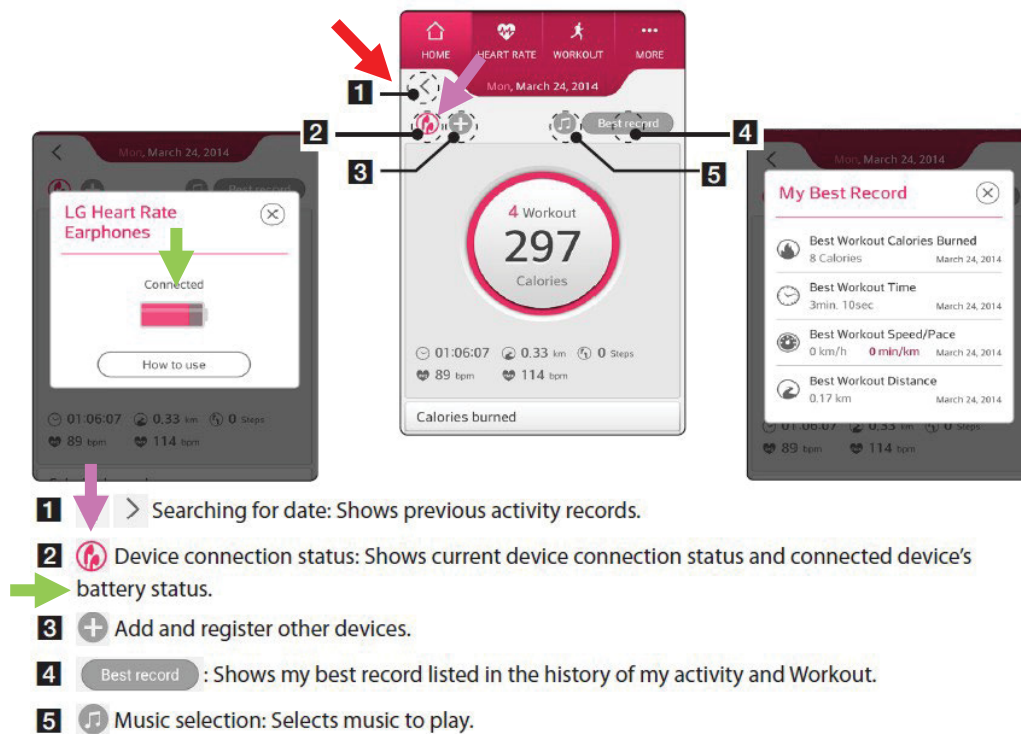


Ex-1005-LG-Manual, 36. For example, like Hensen-Video, LG-Manual teaches a user interface displays a visual representation of left and right earpieces (e.g., an icon showing a silhouette of the earpieces (red arrow)).

139. LG-Manual also teaches the additional limitations of Claim 5 that recite that the visual representation includes lighting the earpieces. For example, as shown

above, LG-Manual's visual representation of the earpieces transforms from gray to pink lighting (pink arrow) when the earpieces are connected to the smartphone. *Id.* ("Connecting: You can register fitness devices other than LG Heart Rate Earphones and check the connection status. Select desired device and the screen for connection status and/or adding new devices"). This use of lighting in LG-Manual's visual representation would have been readily understood because, as shown above, visual representations of devices that are not connected or paired (e.g., the LG Lifeband Touch, the Polar heart rate monitor, and the Zephyr heart rate monitor) have no pink lighting and are instead grayed out.

140. Additional screenshots from the LG-Manual user interface are shown below.



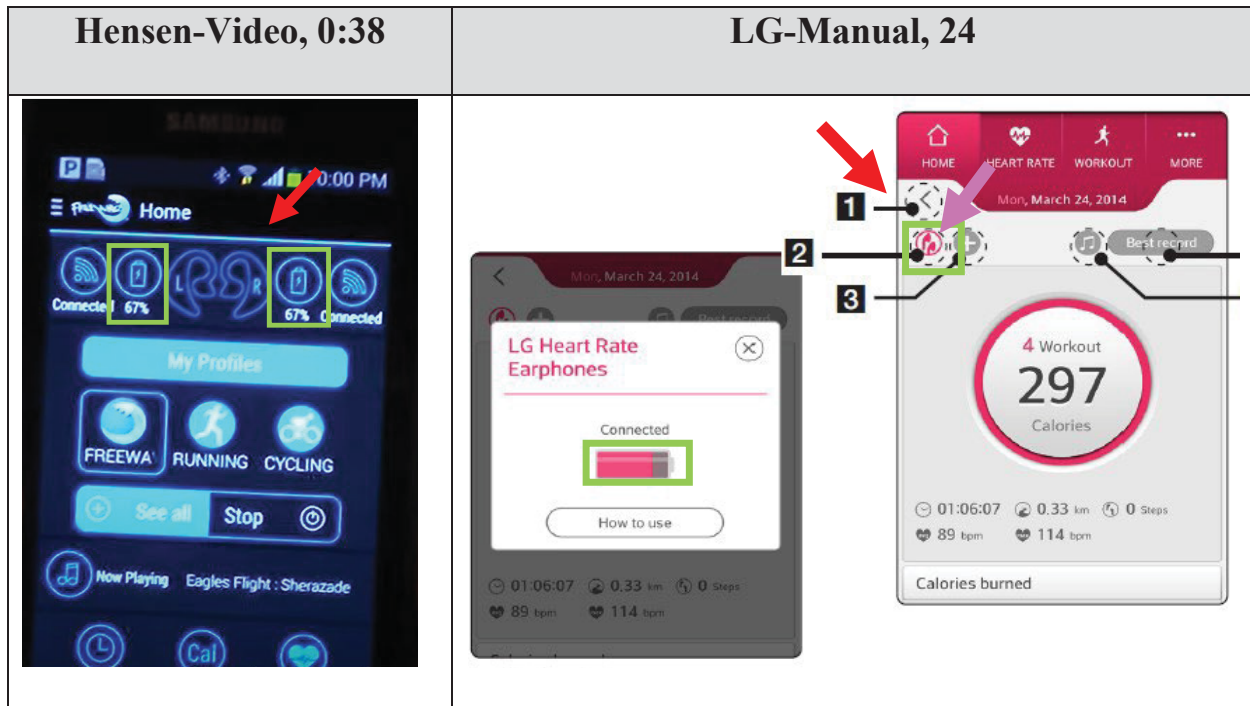
Ex-1005-LG-Manual, 24 (“Home menu: You can check my current workout information, LG Fitness device connection status and total workout information”).

In addition to showing the connection status, LG-Manual’s visual representation of the earpieces (red arrow) with lighting (pink arrow) is also associated with battery life (green arrow).

141. A POSITA would have been motivated to combine the teachings of LG-Manual with those of Hensen-Patent and Hensen-Video. As an initial matter, the three references all describe wireless earpiece systems with a remote control device. Ex-1005-LG-Manual, 19 (“Using the Handsfree function: To use handsfree function, you must pair LG Heart Rate Earphones via Bluetooth to your

smartphone.... To control music through the LG Heart Rate Earphones, you must pair device via bluetooth to your smartphone.”), 21-22; Ex-1003-Hensen-Patent, 8:14-31, Claim 14; Ex-1004-Hensen-Video, 0:09-0:19 (“I'm currently wearing both the right and left units. I've already turned them on. I've paired them with other and also paired with the source device, in this case, a smartphone”). In particular, the three references all describe that the wireless earpieces have heart rate monitoring functionality such that they can be used for fitness tracking in conjunction with the remote control device. Ex-1005-LG-Manual, 31 (“Checking the heart rate during the workout: 1. Pair LG Heart Rate Earphones with LG Fitness app....”); Ex-1009-Hensen-Provisional, ¶14; Ex-1004-Hensen-Video, 0:48-1:09 (“I'm going to go ahead and show all, and you can see not only my heart rate but my oxygen saturation at 95%.”).

142. The benefits of the combination would have been evident because the wireless earpiece system of Hensen-Patent and Hensen-Video displays connection status and battery life data from the earpieces, and LG-Manual shows how a visual representation with lighting can be an effective and compact way to convey this information on a graphical user interface. A side-by-side comparison of Hensen-Video and LG-Manual’s user interfaces is shown below.



Compared to Hensen-Video's visual representation, LG-Manual's visual representation with lighting (pink arrow) takes up less space on the screen (e.g., the visual representation is normally just a small icon, and the user can select the visual representation to view more detailed information such as battery life in an overlay).

143. In addition, a POSITA would have readily incorporated suitable graphical user interface elements as a matter of routine design choice when designing the software application and arranging the user interface. One such routine design choice would have included deciding whether to use known lighting techniques to emphasize a property of the earpieces (e.g., connection status and battery life), as taught by LG-Manual.

144. Using LG-Manual's visual representation with lighting in the wireless earpiece system of Hensen-Patent and Hensen-Video would have amounted to the use of a known technique to yield predictable results. For example, the predictable results would have included the ability to display data from the earpieces in a simple and space-efficient manner. A POSITA would have combined the teachings of Hensen-Patent, Hensen-Video, and LG-Manual with a reasonable expectation of success given that LG-Manual's visual representation would be used for its intended purpose of displaying connection status and battery life data from wireless earpieces.

2. Claim 6: The system of claim 5 wherein the lighting is associated with the function or property of the at least one wireless ear piece.

145. As I explained for Claim 5, the combination of Hensen-Patent, Hensen-Video, and LG-Manual teaches that the lighting is associated with the function or property (e.g., battery life) of the at least one wireless earpiece. *See, e.g.*, Ex-1005-LG-Manual, 24 ("Device connection status: Shows current device connection status and connected device's battery status"); Ex-1004-Hensen-Video, 0:32-0:38 ("I want to show you this home screen. I'm going to hold it real still. Now at the top you're going to see each unit and the battery life."); Ex-1003-Hensen-Patent, 8:26-31.

3. Claim 7: The system of claim 6 wherein the property is remaining battery life.

146. As explained above for Claim 6, the combination of Hensen-Patent, Hensen-Video, and LG-Manual teaches that the property is remaining battery life.

C. Ground 3

1. Claim 8: The system of claim 1 wherein the user interface is further configured to display available gestures associated with controlling the at least one wireless ear piece.

147. As explained in further detail below, claim 8 would have been obvious over the combined teachings of Hensen-Patent, Hensen-Video, and Lee. As I explained in Section IX.A.1 (Ground 1), the combination of Hensen-Patent and Hensen-Video teach each of the limitations of claim 1. Meanwhile, the combination of Hensen-Patent, Hensen-Video, and Lee teaches the additional features of claim 8.

(i) Hensen-Patent and Hensen-Video

148. As I explained for Element [1D], Hensen-Patent in combination with Hensen-Video teaches a user interface that displays information (e.g., volume settings) associated with controlling the wireless earpieces. Ex-1003-Hensen-Patent, 8:24-34 (“The remote control unit 51 also includes a display 53 that may display ... information about the stereo audio headphones, for example, volume and/or battery power remaining.”); *see also* Ex-1009-Hensen-Provisional, ¶¶1, 14, 35, 42; Ex-1004-Hensen-Video, 0:32-0:38.

149. Hensen-Patent also teaches that the wireless earpieces have input devices 37 that can be used to control the wireless earpieces (e.g., adjusting the volume). Ex-1003-Hensen-Patent, 5:37-47 (“The input devices 37 may be for adjusting volume, and stereo audio source selection.”). Hensen-Patent identifies an exemplary implementation of input devices 37 (push buttons) but states that other known types of input devices could be used (such as the gesture-based input devices taught by Lee, as explained in greater detail below). *Id.* (“Input devices 37 are illustratively carried by the master housing 31. The input devices 37 may be push buttons and may be coupled to the master circuitry 32.... Other types of input devices may be used and may correspond to different command and/or function, as will be appreciated by those skilled in the art.”).

(ii) Lee

150. Lee teaches the additional limitations of Claim 8 requiring the user interface to display available gestures associated with controlling the at least one wireless ear piece.

151. Figure 3 of Lee is reproduced below.

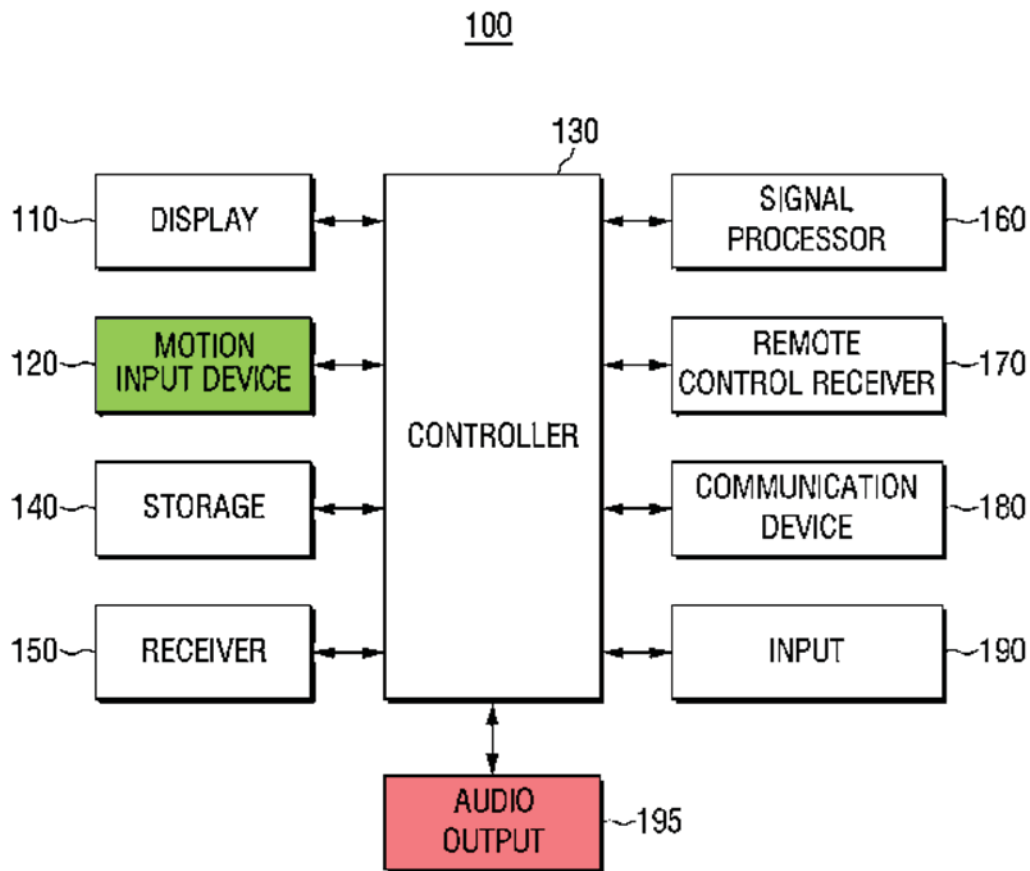
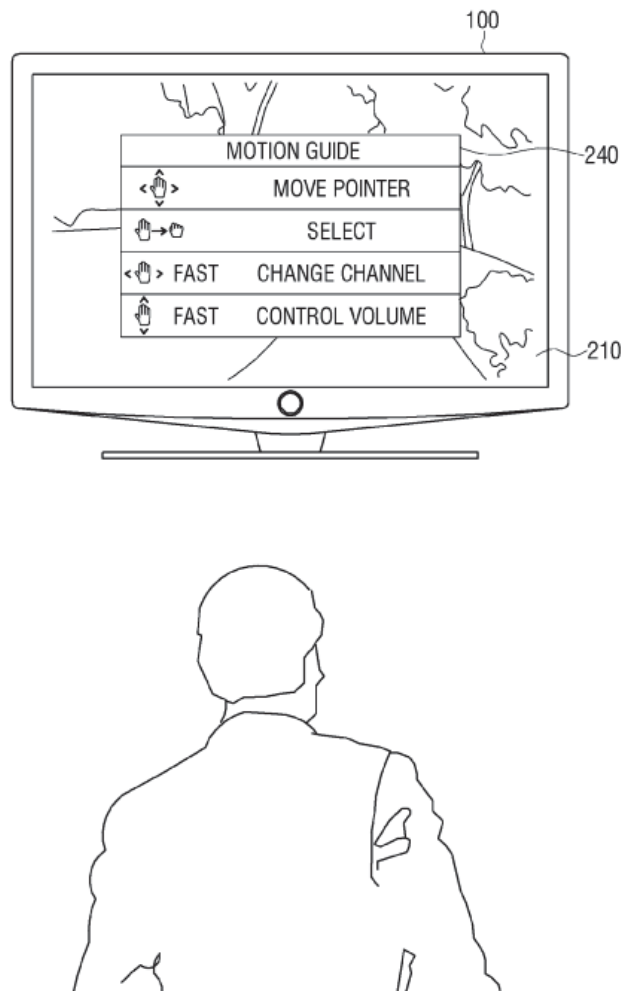


Figure 3 shows that a gesture-based input device (e.g., motion input device 120 (green)) is used to control (e.g., set the volume of) an audio device (e.g., a display apparatus 100 having an audio output 195 (red)). Ex-1006-Lee, ¶¶47 (“The controller 130 may control to recognize a motion input through the motion input device 120 and perform a task corresponding to the recognized motion (such as, the motion of moving a pointer, selecting a GUI using the pointer, turning power on/off, changing channels, controlling volume, reproducing contents, performing web browsing, and so on).”), 77 (“the display apparatus 100 may further comprise a storage 140, a receiver 150, a signal processor 160, a remote control signal receiver

170, a communication device 180, an input 190, and an audio output 190 [*sic*: 195]”),
10, 24.

152. Referring to Figure 6A below, Lee also teaches a user interface that displays available gestures associated with the gesture-based interface.



Ex-1006-Lee, Figure 6A. Figure 6A shows that a “motion guide” displays the available gestures associated with controlling the audio device (e.g., adjusting the

volume of audio output 195). *Id.*, ¶96 (“As illustrated in FIG. 6A, when the motion by a user of clenching a hand is input through the motion input device 120 while the pointer 220 is located on the GUI 230 to provide a motion guide, the controller 130 performs a function corresponding to the GUI 230. That is, the controller 130 may display a guide 240 (FIG. 6B) including information regarding available motions on the screen as illustrated in FIG. 6B.”).

153. Lee was cited by the Examiner during examination of the '385 patent. Ex-1011-FH [PDF199] (Office Action at 8). In particular, the Examiner identified Lee as disclosing the limitations of then-numbered claim 9 (now claim 8). *Id.* (“Lee discloses a display for an electronic unit to display available motions or gestures for the user in controlling the electronic device.... [I]t would have been obvious to [a POSITA] to utilize the guide disclosed by Lee ... so that the user [is] informed and comfortable regarding the motions available for controlling the electronic device”). The applicant did not substantively respond to the Examiner’s conclusions that Lee teaches the limitations of claim 8 and that a POSITA would have been motivated to combine Lee with the primary references. *See, e.g.*, Ex-1011-FH [PDF272] (Appeal Brief at 51) (the applicant’s only argument for the allowability of then-numbered claim 9, now claim 8, was based on its dependency from claim 1).

154. Thus, the combination of Hensen-Patent, Hensen-Video, and Lee teaches a user interface that displays available gestures (e.g., Lee’s motion guide)

associated with controlling a wireless earpiece (e.g., setting the volume of Hensen-Patent's wireless earpieces adapted to include a gesture-based input device as taught by Lee).

(iii) Motivation to Combine

155. A POSITA would have been motivated to combine the teachings of Lee with Hensen-Patent and Hensen-Video. As I explained above, the applicant did not challenge the conclusions of the Examiner of the '385 patent regarding Lee, including that "it would have been obvious to [a POSITA] to utilize the guide disclosed by Lee ... so that the user [is] informed and comfortable regarding the motions available for controlling the electronic device." Ex-1011-FH [PDF199] (Office Action at 8).

156. In addition to reasons given by the Examiner, a POSITA would have been motivated to combine Lee, Hensen-Patent, and Hensen-Video with a reasonable expectation of success. For example, the three references describe similar types of user interfaces for interacting with electronic devices. Ex-1006-Lee, ¶¶24 ("According to various exemplary embodiments, it is possible to control a display apparatus by a user's motion and thus, user convenience can be improved"), 10; Ex-1003-Hensen-Patent, 8:14-31; Ex-1004-Hensen-Video, 0:09-0:19. Specifically, Lee and Hensen-Patent both disclose techniques for setting the volume of an audio device. Ex-1006-Lee, ¶47 ("The controller 130 may control to recognize

a motion input through the motion input device 120 and perform a task corresponding to the recognized motion (such as, the motion of moving a pointer, selecting a GUI using the pointer, turning power on/off, changing channels, controlling volume, reproducing contents, performing web browsing, and so on).”), ¶77; Ex-1003-Hensen-Patent, 5:37-47 (“Input devices 37 are illustratively carried by the master housing 31.... The input devices 37 may be for adjusting volume, and stereo audio source selection.”).

157. A POSITA would have had further reason to combine Lee with Hensen-Patent because Hensen-Patent states that its wireless earpiece system can be used with different types of known input devices for functionality such as setting the volume of the earpieces, and Lee teaches gesture-based input device that can provide this functionality in a convenient and intuitive manner. Ex-1003-Hensen-Patent 5:37-47 (“The input devices 37 may be push buttons and may be coupled to the master circuitry 32.... Other types of input devices may be used and may correspond to different command and/or function, as will be appreciated by those skilled in the art.”); Ex-1006-Lee, ¶¶24 (“According to various exemplary embodiments, it is possible to control a display apparatus by a user's motion and thus, user convenience can be improved”), 10. Hensen-Patent therefore instructs POSITA to seek out teachings regarding input devices and would have readily found Lee’s teachings of a convenient gesture-based input device to be suitable for this purpose.

158. Lee also teaches that there are advantages associated with its user interface that displays a motion guide, including that the motion guide is capable of grabbing the user's attention while minimizing interference with the user interface. Ex-1006-Lee, ¶11 (“An aspect of the exemplary embodiments relates to a display apparatus which is controlled by a user's motion, and draws the attention of a user to a motion guide when the guide regarding available motions is provided, while minimizing interference with the display apparatus, and a method for controlling a display apparatus thereof.”). Hensen-Patent instructs a POSITA to seek out such teachings regarding user interfaces to display information associated with earpieces. *See, e.g.*, Ex-1003-Hensen-Patent, 8:24-34. A POSITA therefore would have been motivated by the teachings of Hensen-Patent to seek out Lee's teachings regarding displaying a motion guide, particularly given the benefits of a motion guide taught by Lee.

159. Using Lee's gesture interface and motion guide in the system of Hensen-Patent and Hensen-Video would have yielded predictable results. Namely, it would have provided the user with a convenient gesture-based interface to control the wireless earpieces as well as with information (a motion guide) that increases the user's knowledge and comfort with the available gestures. The combination would have been carried out with a reasonable expectation of success given that Lee's

gesture interface and motion guide would be used in a similar system for its intended purpose of controlling an audio device.

D. Grounds 4-6

160. As explained in further detail below, claims 1-4 and 9-16 would have been obvious over the combined teachings of Hensen-Patent and Hensen-Kickstarter; claims 5-7 would have been obvious over the combined teachings of Hensen-Patent, Hensen-Kickstarter, and LG-Manual; and claim 8 would have been obvious over the combined teachings of Hensen-Patent, Hensen-Kickstarter, and Lee. These are the same combinations of references as those in Grounds 1-3, except that Hensen-Video is replaced by Hensen-Kickstarter. Accordingly, my analysis below focuses on comparing the teachings of Hensen-Video and Hensen-Kickstarter. For the remaining references (Hensen-Patent, LG-Manual, and Lee), I incorporate my explanations provided in Grounds 1-3.

161. Hensen-Kickstarter is an “update” posted on the Kickstarter website on November 22, 2014. Ex-1007-Hensen-Kickstarter. A snapshot of Hensen-Kickstarter was stored by the Internet Archive on September 24, 2015, which is before the claimed priority date of the ’385 patent. Ex-1023.

162. Like Hensen-Patent and Hensen-Video, Hensen-Kickstarter is associated with Dr. Eric Hensen and the FreeWavz commercial product. *See* Sections VII and IX.A.1(c)(iii). For example, Hensen-Kickstarter was published

using the FreeWavz Kickstarter account and includes a variety of references to the FreeWavz product and logo. *See, e.g.,* Ex-1007-Hensen-Kickstarter, 1-2. In addition, Hensen-Kickstarter identifies Dr. Hensen as the founder of FreeWavz – his biography appears on another page of the Kickstarter website that is hyperlinked within the Hensen-Kickstarter post. Ex-1022.

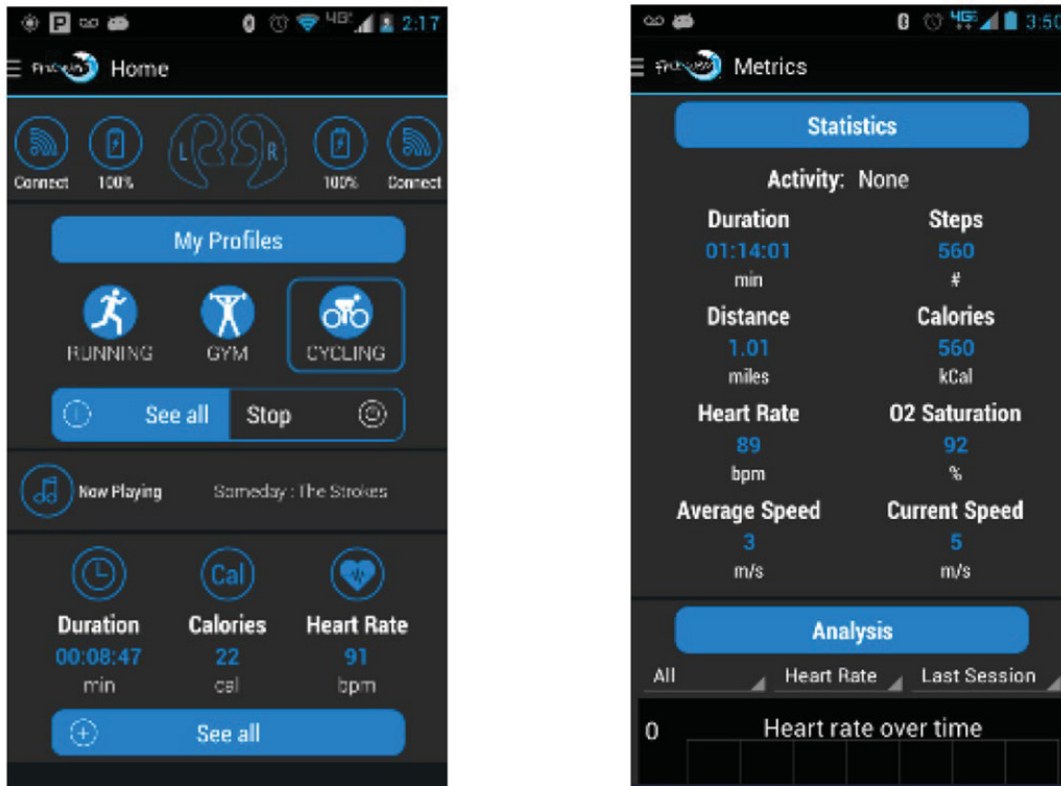
163. As I explain below, the teachings of Hensen-Kickstarter and Hensen-Video are substantially the same with respect to all limitations for which Hensen-Video was cited in Grounds 1-3. Claims 1-16 therefore would have been obvious over Hensen-Kickstarter and the other references in Grounds 1-3 for the same reasons that they would have been obvious over Hensen-Video and the other references in Grounds 1-3.

164. Hensen-Kickstarter and Hensen-Video both describe features of the FreeWavz wireless earpiece system. As shown below, the wireless earpieces in Hensen-Video and Hensen-Kickstarter have substantially the same design.

Hensen-Video, 2:23	Hensen-Kickstarter, 2
	

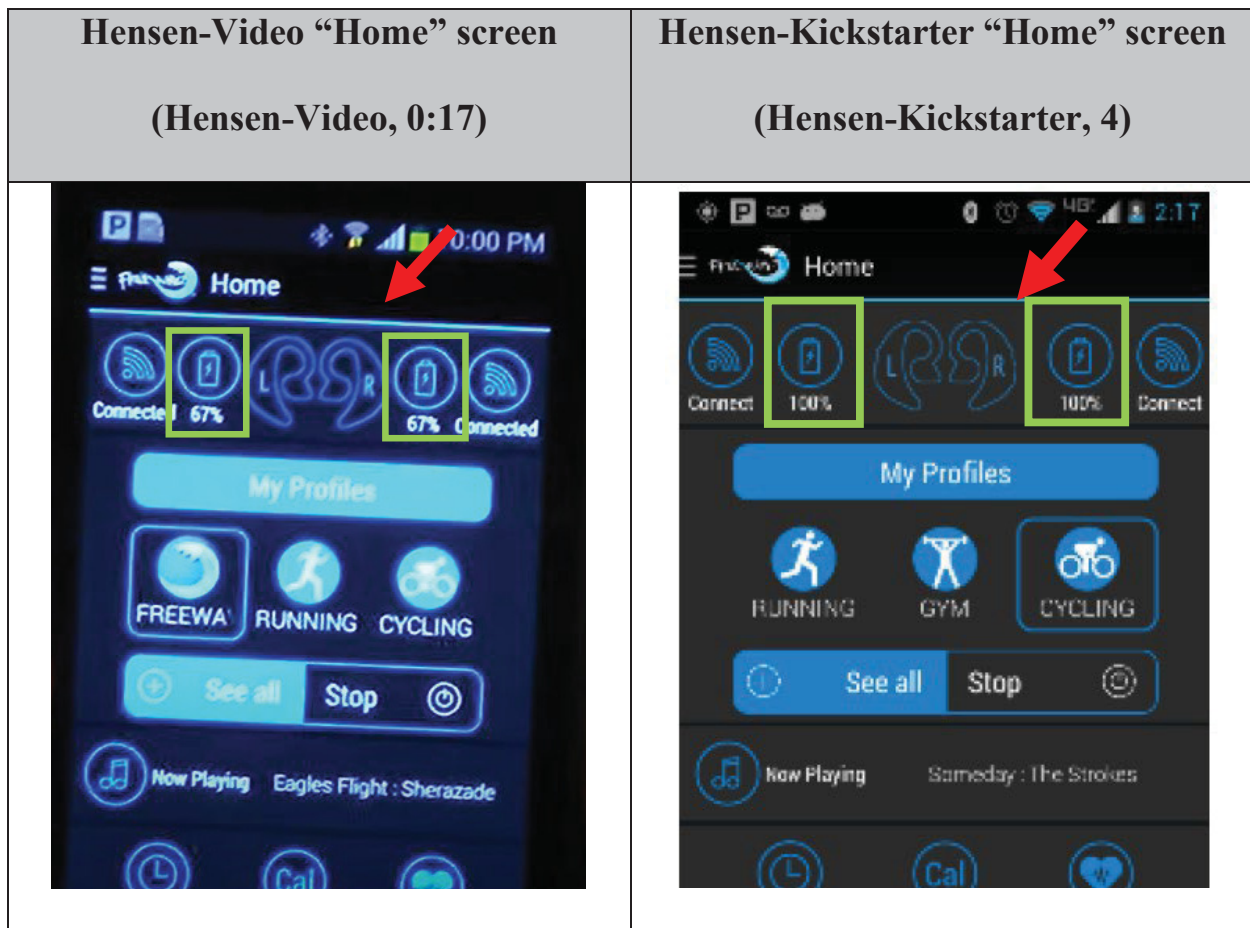
See also Ex-1007-Hensen-Kickstarter, 2 (“FreeWavz provide complete freedom from wires”).

165. With respect to Elements [1B], [1C] and [13B] and Claims 11-12, which recite features related to the software application and display screens, Hensen-Video and Hensen-Kickstarter both describe the FreeWavz software application and display screens. For example, screenshots of the home screen display (left) and metrics screen display (right) from Hensen-Kickstarter are shown below.



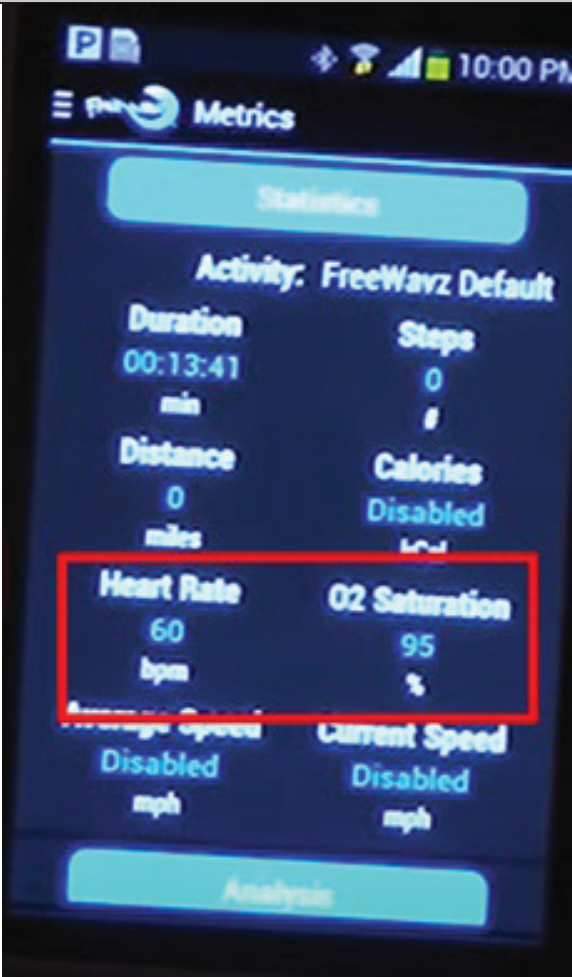
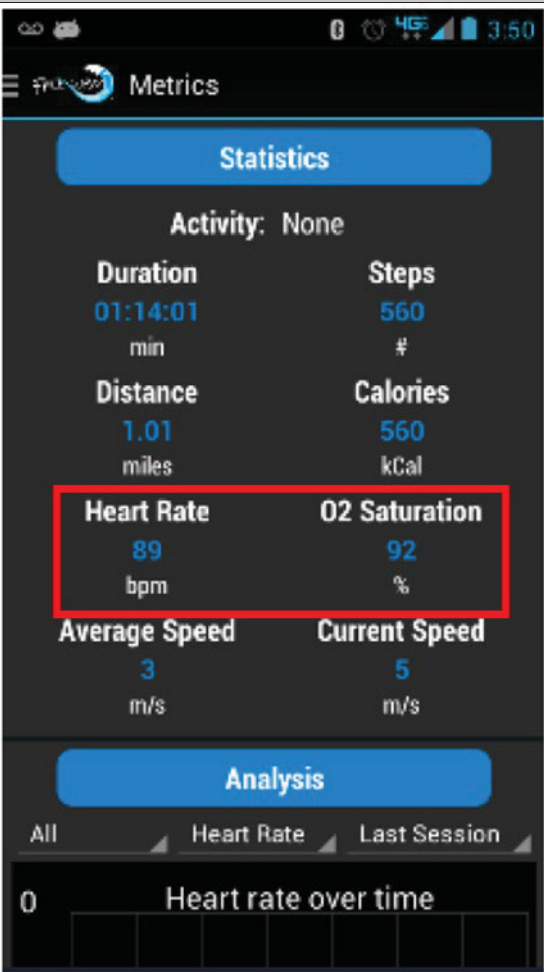
Ex-1007-Hensen-Kickstarter, 4-5. The screenshots show that the FreeWabz software application runs on a remote control device (e.g., an Android smartphone) and causes the smartphone display to show various display screens. *Id.*, (“The Android app is just about finished. Here are some sample page screen shots to demonstrate their appearance”). The screenshots also show that the software application connects to the earpieces (e.g., via Bluetooth), as indicated by the “connect” icons at the top of the home screen display. *Compare with* Sections IX.A.1(c)(ii), IX.A.1(d), IX.A.7, IX.A.8, IX.A.9(c) (citing corresponding teachings of Hensen-Video for Elements [1B], [1C] and [13B] and Claims 11-12).

166. With respect to Elements [1D], [1E], [14E], and Claims 5 and 6, which recite features related to the visual representation, Hensen-Video and Hensen-Kickstarter both disclose that the FreeWavz software application displays a visual representation of the wireless earpieces, as shown below.



The screenshots show nearly identical arrangements of graphical user interface elements, including the same visual representation of the earpieces (red arrows) used to indicate the remaining battery life (green) of the earpieces. *Compare with* Sections IX.A.1(f), IX.A.10(f), IX.B.1, IX.B.2 (citing corresponding teachings of Hensen-Video for Elements [1D], [1E], [14E] and Claims 5 and 6).

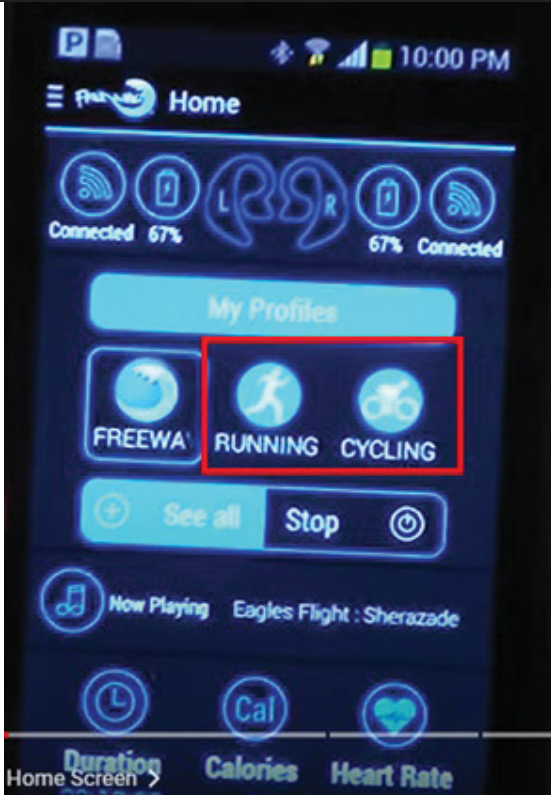
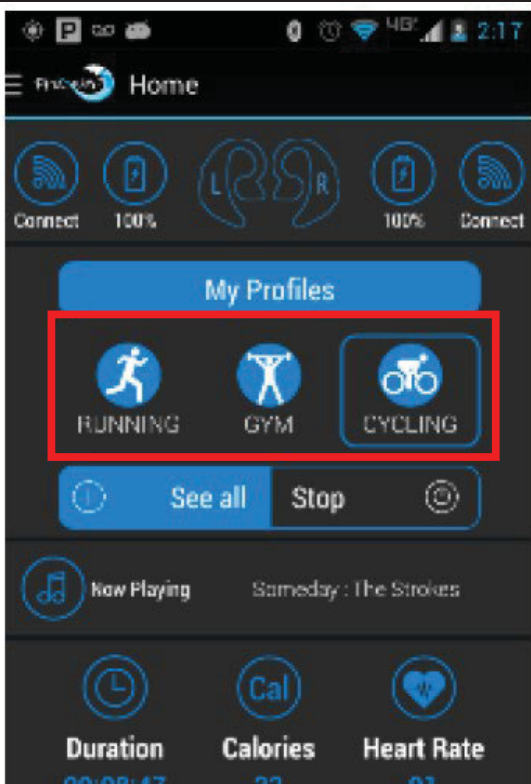
167. With respect to Claims 3 and 15 and Element [14E], which recite features related to tracking and displaying physiological data, Hensen-Video and Hensen-Kickstarter both disclose that the FreeWavz software application tracks and displays physiological data, as shown below.

Hensen-Video “Metrics” screen (Hensen-Video, 0:48-1:09)	Hensen-Kickstarter “Metrics” screen (Hensen-Kickstarter, 5)
	

These images show the FreeWavz software application tracking and displaying the same data (e.g., heart rate and oxygen saturation) received from physiological

sensors (e.g., pulse oximeters). *See also* Hensen-Kickstarter, 1 (“FreeWavz: Smart Earphones with Built-in Fitness Monitoring”), 2 (“FreeWavz provide complete freedom from wires, have a naturally perfect fit and deliver the fitness metrics you want, when you want them”), 4 (“on-ear tuning of biometric algorithms”), 6 (“Tracking-Activity/Metric/Time”). *Compare with* Sections IX.A.3(ii), IX.A.10(f), IX.A.11 (citing corresponding teachings of Hensen-Video for Claims 3 and 15 and Element [14E]).

168. With respect to Claim 4, which recites features related to selecting physical activities, Hensen-Video and Hensen-Kickstarter both disclose that the FreeWavz software application allows the user to select among physical activities (e.g., running and cycling) to be tracked.

Hensen-Video “Home” screen (Hensen-Video, 0:38)	Hensen-Kickstarter “Home” screen (Hensen-Kickstarter, 4)
	

Compare with Section IX.A.4 (citing corresponding teachings of Hensen-Video for Claim 4).

169. Hensen-Kickstarter therefore teaches, in a closely analogous (if not identical) manner, each of the limitations for which Hensen-Video was cited in Grounds 1-3.

170. A POSITA would have been motivated to combine the teachings of Hensen-Kickstarter with those of Hensen-Patent for the same reasons that I explained in Grounds 1-3 for Hensen-Video and Hensen-Patent. See Section

IX.A.1(c)(iii). For example, as I explained above, a POSITA would have sought out the teachings of Hensen-Patent for further details of the system described in Hensen-Kickstarter (and vice versa) given that Hensen-Kickstarter and Hensen-Patent share the same author/inventor and relate to the same commercial product. The teachings of Hensen-Patent and Hensen-Kickstarter relate to similar wireless earpiece systems with a remote control device, where the remote control device receives physiological data (e.g., heart rate and oxygen saturation) from the earpieces.

171. In addition to the reasons to combine that correspond to those provided for Grounds 1-3, a POSITA would have been motivated to use Hensen-Kickstarter's techniques as evidenced by public praise that was given to the FreeWavz system described in Hensen-Kickstarter, e.g., the system was selected for the 2015 CES Innovation Award in Wearable Tech. Ex-1007-Hensen-Kickstarter, 8-9 ("To be considered for this award, products are ... evaluated on their engineering, aesthetic and design qualities, intended use/function and user value, how the design and innovation of the product directly compares to other products in the marketplace and unique/novel features present. Products chosen as CES Innovation Honorees reflect innovative design and engineering in some of the newest tech products and services coming to market. FreeWavz scored highly across all judging criteria.").

172. Finally, the similarities between the software applications described in Hensen-Kickstarter and Hensen-Video means that the combination of Hensen-

Kickstarter and Hensen-Patent would have been carried out with a reasonable expectation of success for the same reasons as those described in Section IX.A.1(c)(iii).

X. AVAILABILITY FOR CROSS EXAMINATION

173. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time allotted for cross examination.

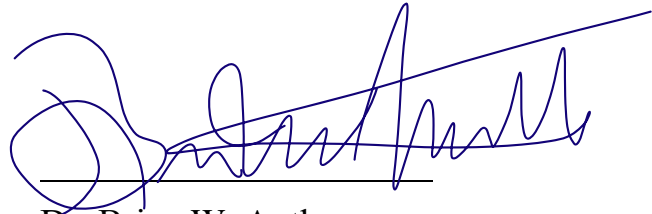
XI. RIGHT TO SUPPLEMENT

174. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises and to take into account new information as it becomes available to me.

XII. JURAT

175. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: May 9, 2023



Dr. Brian W. Anthony

Exhibit A

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
School of Engineering Faculty Personnel Record

Name: Brian W. Anthony

Department: Mechanical Engineering / Institute of Medical Engineering and Science

1. Date of Birth: July 1972

2. Citizenship: USA

3. Education:	<u>School</u>	<u>Degree</u>	<u>Date</u>
	Carnegie Mellon University	BS	1994
	MIT	SM	1998
	MIT	PhD	2006

4. Title of Thesis for Most Advanced Degree:
Video Based System Monitoring

5. Principal Fields of Interest:
Biomedical Imaging, Computational Instrumentation, Device Design and Manufacturing,
Innovation and Product Realization, Ultrasound Imaging

6. Name and Rank of Other Department Faculty in the Same Field:
Harry Asada, Professor
Ian Hunter, Professor
Kamal Youcef-Toumi, Professor

7. Non-MIT Experience (including military service):			
<u>Employer</u>	<u>Position</u>	<u>Beginning</u>	<u>Ending</u>
LANL	Scientist	1992	1994
Independent Consultant	Consultant	1994	1998
Xcitex	CoFounder / CTO	1998	2005
Cooper Perkins	CTO	2005	2007
dRNome	CoFounder	2011	2016

8. History of MIT Appointments:		
<u>Rank</u>	<u>Beginning</u>	<u>Ending</u>
Lecturer, Sloan	2006	2009
Lecturer, MechE	2006	(present)
Research Scientist	2006	2013
Principal Research Scientist	2013	(present)
Director Singapore MIT Alliance – Manufacturing Systems and Technology Program (SMA-MST)	2006	2010
Director Master of Engineering in Manufacturing Program (MEngM)	2006	(present)
Faculty Lead for Education, MIT Skoltech Initiative	2011	2016

Deputy Director, MIT Skoltech Initiative	2014	2016
Associate Director, AIM Academy	2016	2017
Associate Director, MIT.nano	2017	
Faculty Lead for Industry Engagement, MechE	2018	

9. Consulting Record:

Engagements greater than 3 months.

<u>Firm</u>	<u>Beginning</u>	<u>Ending</u>
Los Alamos National Labs		2000
Textron		2000
Federal Trade Commission		2000
FAA		2004
Kodak		2004
Redlake		2005
Olympus		2006
TIS	2009	2012
Photron	2009	2011
Cooper Perkins	2010	2012
IDEO	2012	---
Alcon	2012	---
Ximedica	2013	2014
Herman Miller	2014	2014
Novartis	2015	2015
Lenze	2015	2016
Baxter	2019	2019
Apple	2017	

10. Professional Service

<u>Activity</u>	<u>Beginning</u>	<u>Ending</u>
MEngM Admissions Committee	2006	present
CDO Admissions Committee	2007	2008
Career Fair – SMA in Singapore, Org Chair	2007	2007
Career Fair – SMA/MIT in Singapore, Org Chair	2008	2008
Mfg. microFluidics Symp, Chair	2009	2010
SMART Proposal Lead on Med Devices	3/2010	9/2010
LMP Summit Co-Chair	2011	2011
MEDRC Workshop, Chair	2012	2012
Pilot IMI Proposal, MIT Lead	5/2012	6/2012
Additive mfg working group, Lead	6/2012	8/2012
Co-Chair Education Workstream, AMP 2.0	2013	2014
MIT's role in reducing the cost of health care	2014	2015
AIM Photonics Workforce Committee	2017	2017
Nextflex Collaboration Lead PI	2016	2017
Campus and Community Health Management	2020	2021
MIT-Skoltech Steering Committee	2017	2022
SPIE Conference Committee	2011	2022

MIT / Tufts CTSI TAP Committee	2020
MIT. nano Leadership Council	2017

11. Awards Received:

<u>Award</u>	<u>Date</u>
National Television Academy, Emmy for Innovative Technical Achievement. "Golf on CBS, SwingVision."	2005
BPLA Invented Here, Featured Honoree	2014

12. Current Organization Membership:

<u>Organization</u>	<u>Offices Held</u>
ASME	
IEEE	
SPIE	
AIUM (American Institute of Ultrasound in Medicine)	
Sigma Xi	
RSNA	

13. Patents and Patent Applications Pending:

1. US Patent 5606130 "Method for determining the octane rating of gasoline samples by observing corresponding acoustic resonances therein."
2. US Patent 6393384 "Apparatus and method for remote ultrasonic determination of thin material properties using signal correlation."
3. US Patent 6226081 "Optical height of fill detection system and associated methods."
4. US Patent 8,333,704, B. Anthony and M. Gilbertson, "Handheld Force-Controlled Ultrasound Probe," Dec 11, 2012
5. US Patent 8,328,725, B. Anthony and M. Gilbertson, "Ultrasound Probe," Dec 18, 2012
6. US Patent 8,382,671, B. Anthony and M. Gilbertson, "Handheld Ultrasound Probe," Feb 26, 2013
7. US Patent 9,121,705, B. Anthony and D. Ljubicic, "Sensor for Simultaneous Measurement of Thickness and Lateral Position of a transparent object," Sept 1, 2015
8. US Patent 9,456,800, Brian W. Anthony, Matthew W. Gilbertson, "Ultrasound scanning system", Oct 4, 2016
9. US Patent 10353191, Circular scanning technique for large area inspection, July 16, 2019.
10. MIT Case 14088, Force Controlled Ultrasound Probe, 16-Dec-09
11. MIT Case 14387, Deformation Estimation and Correction in Elastography with a Handheld Force Controlled Ultrasound Probe, 16-Jul-10
12. MIT Case 14422, High-Speed Profilometer for Manufacturing Inspection, 30-Jul-10
13. MIT Case 14966J, Force Measurement Ultrasound Probe for Sonographer Fatigue Monitoring, 10-Jun-11
14. MIT Case 15012, A 6-DOF Optical System for Freehand 3D Ultrasound, 05-Jul-11
15. MIT Case 15681J, Local Actuation and Control of Stamp Deformation in Microcontact Printing, 06-Jun-12
16. MIT Case 15782, Usability Improvements to a Handheld Force-Controlled Ultrasound Probe, 03-Aug-12

17. MIT Case 15884, Computer-Guided Restoration of Ultrasound Scan Poses by Optical Tracking, 01-Oct-12
18. MIT Case 16160, Quick-Release Mechanism for a Force-Measuring Ultrasound Probe, 22-Feb-13
19. MIT Case 16447, Force-correlated Quantitative Ultrasound Image Analysis, 02-Jul-13
20. MIT Case 17106J, Acoustic Characterization of Superficial Body Fluids, 07-May-14
21. MIT Case 17211J, Wireless Capsule Endoscopic Ultrasound, 24-Jun-14
22. MIT Case 17259K, A Concentric Circle Scanning Technique for Large Area Inspection, 09-Jul-14
23. MIT Case 17260K, Grid-Based Matching for Full-Field Large-Area Deformation Measurement, 09-Jul-14
24. MIT Case 17344, Recovery and Computer-Guided Restoration of Ultrasound Scan Poses Based on Human Skin Features, 21-Aug-14
25. MIT Case 17864J, Ultrasound-Based Individual Scatterer Detection Method Using Scatterer Motion Induced by Acoustic Radiation Force, 21-Apr-15
26. MIT Case 17865, Ultrasound-Based Absolute Scatterer Concentration Measurement Technique: Image Volume Estimation from Scatter Spread Function Extracted From the Image, 21-Apr-15
27. MIT Case 17990, Hydrogel Ultrasound Angle Wedge, 04-Jun-15
28. MIT Case 18074, Joint Camera-Ultrasound Data Acquisition for Limb Scanning, 13-Jul-15
29. MIT Case 18544, An Iterative RTM with a Priori Data to Estimate Bone Thickness Using a Cylindrically Scanning Ultrasound Tomography Scanner, 22-Feb-16
30. MIT Case 18545K, Block-Wise Inversion for the Soundspeed of Human Soft Tissue and Bone Using Ray Based Travel Time Tomographic Techniques, 22-Feb-16
31. MIT Case 18636, Concentric Ring-Based Point Pattern Matching of Skin Features, 05-Apr-16
32. MIT Case, Physical and Chemical Characterization of Aerosols with Photonic Waveguides, United States Patent Application 20190234850
33. MIT Case 19192QJ, Non-Invasive Assessment of Venous Pressure via Actuation of Reciprocal Surface Forces for Vessel Collapse Using Single-Crystal Ultrasound in Vertebrates
34. MIT Case 19409, Medical Ultrasound Device with Integrated Force Measurement and Methods for Data Synchronization
35. MIT Case 19460, Shear Wave Elastography Imaging with External Mechanical Vibration
36. MIT Case 19516, Source and Receiver Tracking for Non-Contact Ultrasound
37. MIT Case 19618, Real Time Imaging of Invisible Micron-Scale Monolayer Patterns on a Moving Web Using Condensation Figures
38. MIT Case 19626TE, Apparatus and Methods for Ultrasound Limb Scanning Under Load
39. MIT Case 19710, A Technique for Imaging Cortical Bone and Soft Tissue Using the Level-Set Method to Regularize Travel-Time and Full Waveform Tomography Techniques
40. MIT Case 19791, On chip Photonic Aerosol Spectrometer
41. MIT Case 19921, Equity Disbursement for Bionic Skins LLC (4914743)
42. MIT Case 20289, Miniaturization of External Mechanical Vibration for Ultrasound Shear Wave Elastography Imaging
43. MIT Case 20506L, Systems and Methods for Enabling Non-Contact Laser Ultrasound
44. MIT Case 21078, Microscale Photoacoustic Spectroscopy and Microscopy
45. MIT Case 21123, Tunable Filler Assembly in Multi-material Polymer Extrusions Using Direct Injection and Acoustic Radiation Forces

46. MIT Case 21145, 3D Organ and Tissue Property Mapping using Superficial Vasculature-Based RGBD-SLAM and Deep Vasculature Alignment
47. MIT Case 22420, Integrated Optofluidic Sensor for Thromboembolic and Coagulation Risk Monitoring in COVID-19 Patients at Point-of-Care
48. MIT Case 22432, High Sensitivity and Specificity, Rapid, Low Cost, On-Chip Covid-19 Virus (and Other Virus) Detection using Integrated Photonic Sensors
49. MIT Case 22652, Dynamic Control of a Fiber Manufacturing Process using Deep Reinforcement Learning
50. MIT Case 23256, Privacy-Preserving Health Diagnosis of Manufacturing Machines
51. Circular scanning technique for large area imaging (US Patent 10,735,674)
52. Method for detecting circulating cells in superficial body fluids (US Patent 10,639,012)
53. Physical and Chemical Characterization of Aerosols with Photonic Waveguides (US Patent 11,181,454)

14. Professional Registration:

N/A.

15. Major New Products, Processes Designs, or Systems:

See next.

16. Major New Products, Processes Designs, or Systems:

The following is split between a) University Programs or Significant Initiatives, b) Products, and c) Companies.

A. Programs, Centers, or Significant Initiatives

MechE Alliance – Industry Immersion Project Program

The I2P Program provides MechE graduate students with an exclusive opportunity to gain real-world experience working on a 3-to-6 month industry project at a participating company while still enrolled at MIT. Project concepts are first proposed by the company, and then refined and improved by students and their faculty advisors to best suit their academic experience and career interests.

Living Lab in IMES

The Sekisui House at MIT established a multi-year and sustained collaboration around specific themes and needs, answer key questions—via targeted projects designed to collect clinically relevant evidence—and generate significant technology innovations. The program will be staffed and operated by clinicians, researchers, and technical instructors, while fostering educational and global exchange between disparate communities, all while highlighting efforts in medical and observational research. The broader MIT community will be engaged with annual workshops and calls for proposals, as well as nominations for faculty and students to join programs surrounding specific themes.

Immersion Lab – MIT.nano

The Immersion Lab is a two-story, state-of-the-art space for research in visualization, augmented and virtual reality (AR/VR), and the depiction and analysis of spatially related data. Housed in MIT.nano, the lab is an open-access research space. The Immersion Lab mission is to propel research and education at MIT by: Providing the community with an array of cutting-edge technologies to facilitate immersive experiences; Broadening interdisciplinary interest in immersive technologies at MIT and promoting collaborations in art, science, and technology; Supporting teaching in enhanced reality and mentoring MIT community members seeking to realize their projects using our facility; Bridging the domains of hardware and software—and encouraging cycles in which advances in one domain spark innovation in the other; Fueling experimentation and research in enhanced reality technologies through seed grants, shared equipment, symposia, and other resources.

MEngM

Former Director of the Master of Engineering in Manufacturing Program, and previously the director of the Singapore MIT Alliance - Manufacturing Systems and Technology Program since 2006. In these roles I have developed an education partnership program with small to multi-national corporations, defined and built the MEngM program and structure for the development and execution of company-based projects. I place student groups into companies, teach professional engineering practice in the contact of industry based group projects, and broadly define and execute the operations of the MEngM degree program.

MEDRC

Co-Founder, Co-Director of the Medical Electronic Device Realization Center (MEDRC). Along with Charlie Sodini, and Joel Voldman, I recruit large Medical Device manufacturing companies, lead research, and engage with the Med Tech community nationally and internationally.

The MEDRC establishes partnerships between the microelectronics industry, the medical devices industry, medical professionals, and MIT faculty, researchers, and students to collaboratively achieve improvements in the cost and performance of medical electronic devices. The successful realization of such a vision also demands innovations in the usability and productivity of medical devices, and new technologies and approaches to manufacture devices. The MEDRC is a focal point for large business, for venture-funded startups, and for the medical community.

MIT Skoltech Initiative

Deputy Director, and Lead Education, MIT Skoltech Initiative. I served as the education faculty lead in the development of high level curriculum concept for SkolTech Master's degree programs, spanning across domains (space, nuclear, biomedicine, IT, and energy). We develop the education-team collaboration, build consensus on vision, objectives, and plans, and to create education programs for each domain.

MIT.nano / SENSE.nano

Associated Director, MIT.nano. Founding director of first center of excellence at MIT.nano, SENSE.nano.

MIT Center for Clinical and Translation Research

Advisor for Clinical Technology Operation. The CCTR provides the facilities needed to conduct safe human research - in concert with colleagues in MIT Medical, the VPR Office of Research Compliance, and the Committee on the Use of Humans as Experimental Subjects (COUHES). The Center embodies a three-part mission: addressing critical needs in translational research within medicine, expanding central resources essential to MIT, and enabling external links to outside schools (Tufts University, Harvard University, Harvard Medical School), hospitals, and agencies (e.g. FDA).

Other Significant, formative, Initiatives

SMART Center - March through September 2010

I developed consensus around a theme, built the team of 10 investigators in Singapore and 10 investigators at MIT for a whitepaper and requested full center-proposal for SMART, entitled “*Realization (Design, Manufacturing, and Use) of Injectable Physiological Monitors – Enabling a Patient Centric Information Driven Healthcare Future.*”

Pilot Innovation Manufacturing Institute (IMI) Proposal – May, June 2012

A team (University of Massachusetts Amherst, University of Connecticut, Massachusetts Institute of Technology, the Connecticut Center for Advanced Technology, the Pennsylvania State University, UMass Lowell, United Technologies Corporation, and the National Center for Manufacturing Sciences) proposed to form an independent, non-profit technical center of excellence to accelerate technological progress and innovation in additive manufacturing (AM), in response to the May 8, 2012 Air Force Research Laboratory Broad Agency Announcement (BAA-122-17-PKM) for the NNMI pilot.

Flexible Hybrid Electronics Manufacturing Innovation Institute (NextFlex) – October 2015

MIT PI on winning proposal, including a team of Marc Baldo, Duane Boning, Vladimir Bulovic, Karen K Gleason, David E Hardt, Anastasios John Hart, Sang-Gook Kim. \$150M national center with a mission to catalyze the development of an ecosystem for manufacturing new forms of electronics that integrate bulk ICs and printed devices with functions such as power, communications, fluidics, and bio-sensing in flexible systems that can bend, fold, stretch, and conform.

B. Products

Fuselage Crack Inspection System for FAA

In support of the Federal Aviation Administration National Aging Aircraft Research Program (NAARP) the state-of-the-art Full-Scale Aircraft Structural Test Evaluation and Research (FASTER) Facility was established at the FAA William J. Hughes Technical Center - I designed, built, and delivered The Remote-Control Crack Monitoring System consisting of a pair of cameras with two different fields of view manipulative by with a large gantry robot. The cameras ‘fly’ over the fuselage surface to identify and track cracks using processed camera images to generate the feedback signal

Laser Wave for Textron

Textron Inc.’s LaserWave® products integrated advanced signal processing techniques, robust software algorithms, lasers, optics and ultrasonic technology. I developed propagation models describing the propagation of the collapsing circular, thermo-elastic, transient Lamb waves. I developed real-time inversion routines using a time-frequency wavelet decomposition to extract and identify group velocity mode shapes. The LaserWave products use models and algorithms that I developed to invert the measured temporal signals to estimate elastic constants and material thickness of thin layers.

Motion Tools for Photron Inc

I designed Photron Motion Tools to operate high-speed PCI cameras. Photron Motion Tools provides users with manual and automatic tracking capabilities. By simply selecting the point of interest within the recorded image sequence, Motion Tools automatically tracks the points-motion within the sequence.

i-Speed for Olympus

Capable of capturing images at speeds from 60 to 150,000 frames per second in 'normal' mode (down to 1 second/frame in 'timelapse' mode) i-SPEED cameras are an effective method of locating problems quickly and easily. I designed custom software to provide the operator with the ability to analyze and enhance high-speed videos. Velocity and distance measurement can also be calculated. The i-SPEED Software Suite was designed to mirror the ease-of-use and high specification power of the camera range.

Swing Vision for CBS

I designed and built the Swing Vision camera system, camera control system, camera mounts, the server architecture, and the analysis software. Two high-speed cameras record a golfer t-shot. A 2000 fps camera records the full view of the golfer. A 12500 frame per second camera is used to record the ball-club interaction. As the 2000 fps video is broadcast in slow motion, the 12500-fps video (gigabytes of raw video data) is **automatically** analyzed (in under 20 seconds). I won an Emmy for this system in 2005.

MiDAS and ProAnalyst - Xcitex

As Xcitex's CTO and first engineer, I developed the core of the flagship products - MiDAS and ProAnalyst. And as CTO and Vice-President of Xcitex, I developed and directed the development of products and solutions for the industrial and scientific video markets.

C. Companies

Xcitex – CoFounder, formerly CTO, formerly Vice-President, Board of Directors

Xcitex was self-funded and grew through solid product development and consistent execution of our business strategy. As Xcitex's first engineer, I developed the core of the flagship products - MiDAS and Pro Analyst. I also describe these products in a document that I include as supplemental material. As CTO and Vice-President of Xcitex, I built the technical team, architected and directed the development of products and solutions for the industrial and scientific video markets. Our products alone fueled our growth from startup to dominant market leader.

dRNOME – CoFounder, Investor, Board of Director

Provided tools for managing, manipulating, archiving, and searching your scientific video. Removed the necessity for its customers to make heavy investments in expensive hardware and software solutions, removes the overhead required to manage high-volume video needs, and we back this with a service level guarantee.

dRNOME Inc. (CueVue.com – Launched in February 2011, sold technology in 2014). Core technologies used to perform automated feature recognition of multiple streaming telemetry sources and to extract metadata and make this information available for ongoing operations, forensics, and security. Products enable multi-camera real-time feature recognition, extraction & tagging automation.

Enumage – CoFounder, Investor, Board of Director

Specializing in Laser Ultrasound.

1. Books:

Smart Manufacturing On-line course, deployed 2019 and 2020

2. Papers in Referred Journals:

- 2.1. B. Anthony, A. Abbate, D. Klimek, P. Kotidis., "Analysis of Ultrasonic Waves in Arbitrarily Oriented or Rotating Anisotropic Thin Materials", *Quantitative Nondestructive Evaluation*. Vol 18. pgs 215 - 222. (1999).
- 2.2. A. Abbate, B. Anthony, D. Klimek, P. Kotidis., "Analysis of Dispersive Ultrasonic Signals by the Ridges of the Analytic Wavelet Transform", *Quantitative Nondestructive Evaluation*. Vol 18. pgs 703 - 710. (1999).
- 2.3. Dan Klimek, Brian Anthony, Agostino Abbate, Petros Kotidis, "Laser Ultrasonic Instrumentation for Accurate Temperature Measurement of Silicon Wafers in Rapid Thermal Processing Systems", *Rapid Thermal and Integrated Processing VII*, Materials Research Society, Volume 525, pg 135. (1999)
- 2.4. Hardt, D.E., Anthony, B.W., Tor S.B., "A teaching factory for polymer microfabrication - μ Fac," *International Journal of Nanomanufacturing*, 2010, Vol. 6, No.1/2/3/4, pp. 137 - 151.
- 2.5. Shih-Yu Sun, Matthew Gilbertson, and Brian W. Anthony, "Probe Localization for Freehand 3D Ultrasound by Tracking Skin Features", *Book Section, Medical Image Computing and Computer-Assisted Intervention - MICCAI 2014*, Springer, 2014, Vol. 8674. *Lecture Notes in Computer Science*, Pages 365-372.
- 2.6. Xian Du, Brian W. Anthony, Nigel C. Kojimoto, "Grid-based matching for full-field large-area deformation measurement", *Optics and Lasers in Engineering*, Volume 66, March 2015, Pages 307-319.
- 2.7. Xian Du, Nigel C. Kojimoto, Brian W. Anthony, "Concentric circular trajectory sampling for super-resolution and image mosaicing", *Journal of the Optical Society of America A*, Volume 32, No. 2, February 2015, Pages 293-304.
- 2.8. M. Gilbertson, B. Anthony. "A Force and Position Control System for Freehand Ultrasound", *IEEE Transactions on Robotics*, Volume 31, Issue 4. 2015.
- 2.9. Andrey Kuzmin, Aaron Zakrzewski, Brian Anthony, Victor Lempitsky, "Multi-frame Elastography Using Handheld Force-Controlled Ultrasound Probe". *Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, Volume 62, Issue 8, Pages 1486 – 1500, 2015.
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- 2.16 Anthony, B, et al, “A Pilot Study to Precisely Quantify Forces Applied by Sonographers While Scanning: A Step Toward Reducing Ergonomic Injury”, *WORK: A Journal of Prevention, Assessment, and Rehabilitation*, 2017
- 2.17 Zakrzewski, Aaron M., Anthony, Brian W., "Non-Invasive Blood Pressure Estimation Using Ultrasound and Simple Finite Element Models", *IEEE Transactions on Biomedical Engineering*, 2017
- 2.18 Anthony, B., Fitriana, "Computationally-Efficient Optimal Video-Comparison for Machine Monitoring and Process Control", *Journal of Manufacturing Science and Engineering*, 2017
- 2.19 Lee I, Du X, Anthony B. “Hair segmentation using adaptive threshold from edge and branch length measures,” *Computers in Biology Medicine*, (2017).
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- 2.21 Xian Du, David Hardt, and Brian W. Anthony, “Real time imaging of invisible micron-scale monolayer patterns on a moving web using condensation figure,” *IEEE Transactions on Industry Electronics*, (submitted, in review), 2017.
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 - 2.38 S. Kim, D. D. Kim, and B. Anthony, "Dynamic Control of a Fiber Manufacturing Process using Deep Reinforcement Learning," Submitted Nov. 2019.
 - 2.39 R. Singh, Y. Nie, A. M. Agarwal, and B. W. Anthony, "Inverse Design of Photonic Metasurface Gratings for Beam Collimation in Opto-fluidic Sensing," Submitted Oct. 2019.
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- 3.5. Sun, S., Anthony, B. W., Gilbertson, M. W., "Trajectory-based deformation correction in ultrasound images," *Proceedings of SPIE Vol. 7629, 76290A* (2010).
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- 3.8. Ljubicic, D. M., Anthony, B. W., "3D high-speed profilometer for inspection of micro-manufactured transparent parts," *Proceedings of SPIE Vol. 8082, 808211* (2011).
- 3.9. Anthony, B.W, Hardt, D.E., "Revitalizing US Manufacturing to Capitalize on Innovation – Through Education" 119th ASEE Annual Conference, San Antonio TX, June 10-13, (2012)
- 3.10. Anthony, B. W., Namvari, K., "Dimensional variation of polymer substrate electrode production," *Proceedings of SPIE Vol. 8251, 82510G* (2012).
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- 3.14. Sun, S.-Y, Anthony, B. W. "Freehand 3D ultrasound volume imaging using a miniature-mobile 6-DOF camera tracking system". 2012 IEEE International Symposium on Biomedical Imaging (ISBI), 2-5 May, (2012).
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- 3.16. Sun, S.-Y, Gilbertson, M., Anthony, B. W. "6-DoF Probe Tracking via Skin Mapping for Freehand 3D Ultrasound". 2013 IEEE International Symposium on Biomedical Imaging (ISBI), (2013).
- 3.17. Sun, S.-Y, Gilbertson, M., Anthony, B. W. "Computer-Guided Ultrasound Probe Realignment by Optical Tracking". 2013 IEEE International Symposium on Biomedical Imaging (ISBI), (2013).
- 3.18. Inamdar, T., Anthony, B. W., "Characterizing fluidic seals for on-board reagent delivery," *Proceedings of SPIE* (2013).
- 3.19. Zakrzewski, A., Anthony, B. W. "Quantitative Elastography and its Application to Blood Pressure Estimation: Theoretical and Experimental Results". 2013 IEEE Engineering in Medicine and Biology Society (EMBS), (2013).
- 3.20. Gilbertson, M. Anthony, B.W., "An Ergonomic, Instrumented Ultrasound Probe for 6-Axis Force/Torque Measurement". 2013 IEEE Engineering in Medicine and Biology Society (EMBS), (2013).
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- 3.26. Ranger, Bryan J.; Feigin, Micha; Pestrov, Nikita; Zhang, Xiang; Lempitsky, Victor; Herr, Hugh M.; Anthony, Brian W., "Motion compensation in a tomographic ultrasound imaging system: Toward volumetric scans of a limb for prosthetic socket design," in Engineering in Medicine and Biology Society (EMBC), 2015 37th Annual International Conference of the IEEE , vol., no., pp.7204-7207, 25-29 Aug. 2015.
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- 3.29. Anthony, B. W., "Enhanced ultrasound for advanced diagnostics, ultrasound tomography for volume limb imaging and prosthetic fitting," Proc. SPIE 9790, N. Duric and B. Heyde, Eds., 97900Q (2016).
- 3.30. Fincke, J. R., Feigin, M., Prieto, G. A., Zhang, X., Anthony, B., "Towards ultrasound travel time tomography for quantifying human limb geometry and material properties," Proc. SPIE 9790, N. Duric and B. Heyde, Eds., 97901S (2016).
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- 3.36. Feigin M., Ranger, B., Anthony, B., "Statistical Consensus Matching Framework for Image Registration," IEEE Int. Conf. Pattern Recognition, (2016).
- 3.37. Zakrzewski, A. M., Dhyani, M., Samir, A. E., Anthony, B. W., "Non-Invasive, Non-Occlusive Blood Pressure Estimation Using Ultrasound: Clinical Results (I)," 38th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc. (2016).
- 3.38. Anthony, et al, "Arterial Blood Pressure Estimation Using Ultrasound: Results on Healthy Volunteers and a Medicated Hypertensive Volunteer", 2017 39th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc., accepted (2017).
- 3.39. Anthony, et al, "Non-Invasive Diagnosis of Non-Alcoholic Fatty Liver Disease (NAFLD) using Ultrasound Image Echogenicity", 2017 39th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc., accepted (2017).
- 3.40. Anthony, et al, "Camera-tracking vs. image-based motion compensation in a tomographic limb ultrasound system", 2017 39th Annu. Int. Conf. IEEE Eng. Med. Biol. Soc., (2017).

- 3.41. Fincke JR. Imaging cortical bone using the level-set method to regularize travel-time and full waveform tomography techniques. J Acoust Soc Am. Acoustical Society of America; (2017)
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- 3.44. H. Yang, A. Benjamin, B. Anthony, "Simulation of multi-source external mechanical vibration for shear wave elastography," The Journal of the Acoustical Society of America, 142, 2017
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- 3.48. Zakrzewski, A. M., & Anthony, B. W. (2018). Pre-and-Post Exercise Blood Pressure Estimation from Force-Measured Ultrasound: First Results. Presented at the 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Honolulu, HI.
- 3.49. Donk, F., Yang, H., & Anthony, B. W. (2018). Miniaturization of External Mechanical Vibration for Shear Wave Elastography Imaging. Presented at the 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Honolulu, HI.
- 3.50. Chen, M., Li, Q., Karimian, N., Yeh, H., Duan, Y., Fontan, F., ... Samir, A. E. (2018). Contrast-Enhanced Ultrasound to Quantify Perfusion in a Machine-Perfused Pig Liver. Presented at the 2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Honolulu, HI.
- 3.51. Wang, Y. J., & Anthony, B. W. (2018). Characterization of wave fields using transient motion of microspheres under acoustic radiation force. Presented at the 21st International Symposium on Nonlinear Acoustics, Santa Fe, NM.
- 3.52. Yang, H., Carrascal, C., Xie, H., Shamdasani, V., Anthony, B.W., "Design and Experimental Validation of Miniature External Mechanical Vibrators towards Clinical Ultrasound Shear Wave Elastography", IUS, 2018.
- 3.53. Singh, Robin; Ma, Danhao; Kimerling, Lionel; Agarwal, Anuradha; Anthony, Brian, "Microscale photoacoustic spectroscopy using integrated photonics for lab-on-chip applications", Spie BIOS, (accepted), 2018.
- 3.54. J. B. Frontin and B. W. Anthony, "Quantifying Dermatology: Method and Device for User-Independent Ultrasound Measurement of Skin Thickness," in 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2019, pp. 5743–5748.
- 3.55. A. Benjamin et al., "Renal volume reconstruction using free-hand ultrasound scans," J. Acoust. Soc. Am., vol. 145, no. 3, pp. 1922–1922, Mar. 2019.
- 3.56. A. Y. Huang and B. W. Anthony, "An Instrumented Ultrasound Probe for Shear Wave Elastography With Uneven Force Distribution," in 2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2019, pp. 6208–6211.
- 3.57. Feigin M, Zwecker M, Freedman D, Anthony BW. Detecting muscle activation using ultrasound speed of sound inversion with deep learning. Proc Annu Int Conf IEEE Eng Med Biol Soc EMBS. 2020 Oct 20;2020-July:2092–5.

- 3.58. Li Y, Kim DD, Anthony B. HapticWall - An Ecountered-type Two-Dimensional Vertical System for Virtual Reality. Dyn Syst Control Conf. 2020;1–9.
- 3.59. Feigin M, Zwecker M, Freedman D, Anthony BW. Detecting muscle activation using ultrasound speed of sound inversion with deep learning. In: 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC). IEEE; 2020. p. 2092–5.
- 3.60. Feigin M, Makovsky Y, Freedman D, Anthony BW. High-frequency full-waveform inversion with deep learning for seismic and medical ultrasound imaging. In: SEG Technical Program Expanded Abstracts 2020. Society of Exploration Geophysicists; 2020. p. 3492–6.
- 3.61. Singh R, Agarwal A, Anthony BW. Ultra-high sensitive all-optical photoacoustic transducers. In: Oraevsky AA, Wang L V., editors. Photons Plus Ultrasound: Imaging and Sensing 2020. SPIE; 2020. p. 35.
- 3.62. Singh R, Agarwal A, Anthony BW. Leveraging Integrated Photonics for Ultrasound Sensing Applications. In: Imaging and Applied Optics Congress. Washington, D.C.: OSA; 2020. p. JW5A.7.
- 3.63. Singh R, Su P, Agarwal A, Anthony BW. Integrated Mid-IR Photonics for Gas and Aerosol Sensors. In: Imaging and Applied Optics Congress. Washington, D.C.: OSA; 2020. p. JW5C.7.
- 3.64. Ely G, Fincke J, Zhang X, Anthony BW. Optimizing Transducer Acquisition Scheme for Rapid Ultrasound Tomography of Limbs. In: 2020 IEEE International Ultrasonics Symposium (IUS). IEEE; 2020. p. 1–4.
- 3.65. Cuiffi JD, Wang H, Heim J, Anthony BW, Kim S, Kim DD. Factory 4.0 Toolkit for Smart Manufacturing Training. In: 2021 ASEE Virtual Annual Conference Content Access. 2021.
- 3.66. Hahm KS, Chase AS, Dwyer B, Anthony BW. Indoor Human Localization and Gait Analysis using Machine Learning for In-home Health Monitoring. In: 2021 43rd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC). IEEE; 2021. p. 6859–62

4 Articles in Preparation:

- 4.3 Comparison of Quantitative Ultrasound Methods to Classify Pathological Models of Skeletal Muscle, Ultrasound in Medicine and Biology (accepted, 2022)
- 4.4 Homomorphic Encryption Decision Trees for Machine Wear Prediction, Journal of Manufacturing Systems
- 4.5 Ljubicic, D., Anthony, B., "Sensor for Thickness and Lateral Position of a Transparent Web in a Roll-to-Roll Process", target: IEEE Sensors
- 4.6 Automated force-coupled ultrasound method for calibration-free carotid artery blood pressure estimation, UMB,
- 4.7 In-home Health Monitoring using Floor-based Gait Tracking, Journal of Internet of Things, (accepted, 2022)

5. Internal Memoranda and Progress Reports: List chronologically; number each item. N/A

6. Invited Lectures (as of 2015):

- June 2002, "High-speed software synchronizes images and data", Technology Interview. Vision Systems Design.
- June 2003, 2003 "Highspeed Video and Data", Brian W. Anthony, MIT High-Speed Photography and Videography for Motion Analysis: Systems and Techniques.
- June 2003, 2004, 2005, 2006, "Overview of Machine Vision", Brian W. Anthony, MIT High-Speed Photography and Videography for Motion Analysis: Systems and Techniques.
- June 2006, "Video Event Analysis and Video Event Detection - Video Based System Monitoring". Brian W. Anthony. CSAIL Machine Vision Colloquim.

- July 24, 2008, "Computational Imaging Systems," Samsung Electro Mechanical Research, Korea.
- May 5, 2009, "Video Instrumentation," LMP Seminar, MIT
- January 5-7, 2011, "Automation of a Work Cell for Polymer Microdevice Production: Precise Alignment and Visual Quality Inspection ", The Second Conference on Advances in Microfluidics and Nanofluidics and Asian-Pacific International Symposium on Lab on Chip (AMN-APLOC 2011). Singapore.
- February 11, 2011, "The MEDRC," MassMEDIC Board of Directors Meeting. Greenberg Traurig, International Place, Boston.
- March 23-25 2011, "New Perspectives – similar problems", S2I2 Workshop on Collection Digitization, Field Museum, Chicago
- June 20-22, 2011, "Design, Manufacturing, Information Technology, and Healthcare – enabling an information-driven healthcare future – industry, academia collaborations", Medical Device Manufacturing Summit, Red Rock Casino Resort & Spa, Las Vegas, NV.
- July 6, 2011, "Design, Manufacturing, Information Technology, and Healthcare - enabling an information-driven healthcare future – industry, academia collaborations" Korean Institute of Science and Technology.
- Nov 13-15, 2011, Invited Keynote Talk, "Medical Device Manufacturing - Helping to revitalize US manufacturing to capitalize on innovation," Medical Device Manufacturing Summit, Amelia Island, Florida
- November 18, 2011, Invited Keynote Talk, "Computational Videography in Manufacturing," MIT Center for Biomedical Innovation's Biomanufacturing Summit: Implementing Innovation in Biomanufacturing: The Hurdles and Opportunities, Bartos Theater, Building E15 MIT.
- January 27, 2012, "The MEngM and MEDRC Models and Experiences," MassMEDIC's Workshop on Catalyzing Innovation through Industry / Academic Collaborations.
- March 9, 2012, "Computational Enhanced Manufacturing Inspection Systems" Department of Manufacturing Engineering, Ann Arbor, Michigan
- March 13, 2012, "Computational Instrumentation - designing systems at the intersection of mechanical engineering, electrical engineering, and computer science," LMP Seminar, MIT
- March 15-16, 2012, "Industry, innovation, and entrepreneurship, in graduate education and research," SKTech Education Workshop, Moscow, Russia.
- March 27-28 2012, Invited Keynote Talk, "The Inner Beauty of Computational Enhanced Systems," Technology Review EmTech India Conference, Bengaluru, India.
- June 9, 2012, Invited Moderator, "American Transformations: the Next Industrial Revolution", MIT Graduate Alumni - Tech Reunions, MIT, Cambridge, MA.
- May 22 2013, Invited Speaker, MIT Vienna Conference
- June 16, 2013 , Invited Keynote Talk, "Lessons Learned from the MEDRC," EmTech China Conference, Shanghai, China.
- November 13 2013, Invited Speaker, "Microfluidic Devices Manufacturing - Sensing and Instrumentation Challenges and Opportunities", Lab-on-a-chip Asia, Singapore
- October 2013, Invited Speaker, "Have Russia's Innovation Prospects Stalled or Are You Just Not Looking Hard Enough?", US Russian Business Council (USRBC) Annual Meeting,
- January 2015, Keynote, "Limb Imaging" Wayne State University and Karmanos
- January 2015, Philips Research Alliance
- March 2015, Innovation Summit
- April 2015, World Medical Innovation forum
- May 2015, Emtech Columbia
- May 2015, FHE Industry Innovation Summit
- July 2015, ASU Wearables Summit
- August 2015, Medical Systems Design and Development Keynote, EMBC
- September 2015, Novatis Imaging Summit, Basel Switzerland

Publications of Brian W. Anthony

- September 2015, Digital Health, MA Medical Innovation Summit
- October 2015, “Medical Device Innovation”, Novartis Innovation Summit
- November 2015, AIM / FHE / WFD in Chicago
- February 2016, Keynote Talk, Ultrasonic Imaging and Tomography at SPIE Medical Imaging
- April 2016, PMI Aerosol Summit, Switzerland
- April 2016, Body Coupled Communication and interested in wearable ultrasound
- April, 2016 Keynote NIH Muscle Quality, ICSFR Philadelphia
- May 2016, Monterrey Tec-MIT Summit
- June 2016, Polytechnic University of Madrid, Medical Device Keynote
- August, 2016, NIBIB US/India Workshop on Developing Passive, Cuffless, and Noninvasive Blood Pressure Measurement Technologies, Orlando, FL
- August 2016, FNIH Liver Imaging standards workshop, Keynote
- December 2016, Lowell UMass Wearable Sensor Keynote
- March 2017, AUB Conference, Keynote, Beirut
- July 2017, Embc Keynote
- September 2017, National Academies of Sciences, Engineering, and Medicine, DC. Graduate Education in Manufacturing
- September 2017, Health Sensing Conference Keynote
- December 2017, Innovation in Liver Health, Broad
- February 2018, DARPA Innovation in Sensors for Agriculture, Keynote
- May 2018, Siemens Smart Manufacturing Keynote
- Jul 2018, EMBC Imaging Panel
- October 2018, Bloomberg Live Event in Atlanta – Devices and Manufacturing Keynote
- February 2019, 123sonography Live, Ultrasound Innovation, Keynote
- May 2019, Siemens Smart Manufacturing Keynote
- July 2019, Hacking NanoMedicine
- September 2019, Madrid
- October 2019, Lam Research Symposium – Keynote
- January 2020, Consumer Electronics Show (CES) Ambient Sensing, Special Keynote
- February 2020, Wisconsin Workforce Development, Keynote in Smart Manufacturing
- March 2020, Siemens – Keynote on MiA
- May 2020, IMA Innovation in Digital Manufacturing Keynote
- August 2020, High Value Manufacturing Summit (virtual), Keynote
- May 2021, NCSOFT mini-workshop Chair
- April 2021, EmTech NEXT's Inside Track: Ambient Sensing
- May 2021, Tufts CTSI Translational Research Day, Keynote
- February 2021, NSF IMSI Keynote - Private AI

Theses Supervised by Brian W. Anthony

Summary:

	<u>Total</u>	<u>Completed</u>	<u>In Progress</u>
Bachelor's	5	5	0
Master's	42	35	7
MEng	29	17	12
Engineer's			
<u>Doctoral</u>			
As Supervisor	26	15	11
As Reader	4	3	1

Last	First	Title	Department	Year	
Bachelor's Theses					
Syverud	Brian	<i>Robotic ultrasound manipulator: calibration of position and orientation measurement system</i>	MechE	2009	
Johnson	Michael	<i>Design of a precise X-Y-Theta nanopositioning optical sensor</i>	MechE	2009	
Chai	Lauren	<i>Design of mechanical arterial simulator</i>	MechE	2012	
Ramos	Javier	<i>Design of Force Measurement Probe</i>	MechE	2012	
Mireault	Alfred Norman	<i>Mechanical design of an ultrasonic tomographic imaging system</i>	MechE	2016	

Master's Theses					
Fitriani		<i>Multiscale Dynamic Time and Space Warping</i>	CDO	2008	
Zarrouati	Nadège	<i>A precision manipulation system for polymer microdevice production</i>	MechE	2010	
Gilbertson	Matthew Wright	<i>Handheld force-controlled ultrasound probe</i>	MechE	2010	
Sun	Shih-Yu	<i>Deformation correction in ultrasound imaging in an elastography framework</i>	EECS	2010	
Zakrzewski	Aaron	<i>Multi-scale quantitative elastography and its application to blood pressure estimation</i>	MechE	2013	
Koppaka	Sisir	<i>Imaging Biomarkers for Duchenne Muscular Dystrophy</i>	CDO	2015	
Zhang	Xiang (Shawn)	<i>Design of a single element 3D ultrasound scanner</i>	MechE	2015	
Primack	Willow	<i>Analysis and Productivity Improvement of an Automated Material Handling System through Simulation</i>	LGO	2015	
Churchill	Hugh E.	<i>Cycle-time Analysis and Improvement Using Lean Methods within a Retail Distribution Center</i>	LGO	2015	

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Sazdanoff	Nicholas	<i>Evaluation of postponement in the Drug Product supply chain</i>	LGO	2015	
Kojimoto	Nigel Costello	<i>Ultrasonic inspection methods for defect detection and process control in roll-to-roll flexible electronics manufacturing</i>	MechE	2015	
Kundu	Ina Annesha	<i>Imaging platforms for detecting and analyzing skin features and Its stability : with applications in skin health and in using the skin as a body-relative position-encoding system</i>	MechE	2015	
Conover	Susan	<i>Imaging platforms for detecting and analyzing skin features and Its stability : with applications in skin health and in using the skin as a body-relative position-encoding system</i>	SDM	2015	
Hess	Tylor	<i>Algorithm deployment platform</i>	MechE	2016	
Lee	Kang Qi lan	<i>Computational tools for enabling longitudinal skin image analysis</i>	CDO	2016	
Huang	Athena Yeh	<i>May the force be with you : a medical ultrasound system with integrated force measurement</i>	MechE	2017	
Benjamin	Alex	<i>The (travel) times they are a changing : a computational framework for the diagnosis of non-alcoholic fatty liver disease (NAFLD)</i>	CDO	2017	
Yang	Heng	<i>Ultrasound shear wave elastography imaging with external mechanical vibration</i>	MechE	2017	
Zubajlo	Rebecca	<i>Quantitative biomarkers for tissue characterization</i>	MechE	2017	
Benjamin	Rishon Robert	<i>Silence of the lamb waves</i>	CDO	2017	
Haidar	Samer	<i>Supply chain network strategy for consumer medical device introduction</i>	LGO	2016	
Al-Meer	Mariam	<i>Reducing heart failure admissions through improved care systems and processes</i>	LGO	2017	
Sandford	Michael	<i>Application of 3D printing in medical devices New Product Development</i>	LGO	2017	
Graule	Moritz Alexander	<i>Towards force-correlated ultrasound volume elastography</i>	MechE	2017	
Sun	Mingxiu	<i>Education and practice factory : from factory design to first product delivery</i>	MechE	2018	
Singh	Robin	<i>Whispering photons : on-chip biophotonic integrated circuits for point-of-care diagnostics</i>	MechE	2018	
Beaudoin	Judy	<i>Quantifying dermatology : method and device for user-</i>	MechE	2018	

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		<i>independent ultrasound measurement of skin thickness</i>			
DiAndreth	Chris	<i>Optimization of Downstream Supply Chain Product Flow based on an Integrated Cost-to-Deliver Perspective</i>	LGO	2019	
Puppo	Manuel Martinez	<i>Replenishment in an integrated stock world</i>	LGO	2019	
Lu	Shirley Suet-Ning	<i>Design of dynamically controlled desktop fiber accumulator with tension feedback as part of smart manufacturing educational kit</i>	MechE	2020	
Kim	Sangwoon	<i>Model-free tracking control of an optical fiber drawing process using deep reinforcement learning</i>	MechE	2020	
Chen	Hongling (Holly)	<i>Vascular Imaging System for Longitudinal Registration and Mapping of Superficial Vessels with Quantitative Analysis</i>	IDM	2020	
Chavez	Yasmin	<i>System identification and control of a miniature external mechanical vibration device towards clinical ultrasound shear wave elastography</i>	MechE	2020	
Koeppen	Ryan	<i>Design of Electromechanical Attachments for Improved Ultrasound Imaging Repeatability</i>	MechE	2021	
Goryachev	Ivan	<i>Kiosks for Non-Contact Vital Sign Detection</i>	MechE	2021	
Adiwijaya	Zenia	<i>Tenative: ML for Process control</i>	SDM	2023	expected
Chen	George	<i>Tenative: ML for Process control</i>	MechE	2022	expected
Deshpande	Aniruddha	<i>Tenative: Food manufacturing - ML models</i>	EECS	2023	expected
Dhar	Shreya	<i>Tenative: Education Kit</i>	MechE	2023	expected
Espinoza	Victor Reyes	<i>Tenative: ML for Process control</i>	EECS	2022	expected
Justiniano	Eugenio Caraballo	<i>Tenative: Sound and Light on Cells</i>	MechE	2023	expected
Magana-Salgado	Uriel	<i>Tenative: Muscle Health monitoring</i>	MechE	2023	expected

Master Eng. Theses

Su	Xiangyong	<i>Optimization of labor allocation at a syringe production facility : design proposals</i>	MechE	2008	
Liaw	Sze Sen	<i>Optimization of labor allocation at a syringe production facility using computer simulation</i>	MechE	2008	
Ng	Gar Yan	<i>Optimization of labor allocation at a syringe production facility : work study</i>	MechE	2008	

Theses Supervised by Brian W. Anthony

Linares	Rodrigo	<i>Manufacturability of lab on a chip devices: tolerance analysis and requirements establishment</i>	MechE	2010	
Selvakumar	Sivesh	<i>Manufacturing of Lab-On-a-Chip devices : variation analysis of liquid delivery using blister packs</i>	MechE	2010	
Namvari	Kasra	<i>Manufacturability of lab-on-chip devices : dimensional variation analysis of electrode foils using visual technology</i>	MechE	2011	
Donoghue	Linda	<i>Design of a micro-interdigitated electrode for impedance measurement performance in a biochemical assay</i>	MechE	2011	
Holmes	Jacklyn	<i>Robustness and repeatability of interdigitated electrodes on a substrate tested in an aqueous environment</i>	MechE	2011	
Judge	Benjamin	<i>Thermoplastic bonding of microfluidic substrates</i>	MechE	2012	
Jain	Nikhil	<i>A comprehensive study and validation of high-throughput microscale electrode production using thermal transfer printing techniques</i>	MechE	2012	
Inamdar	Tejas Satish	<i>Manufacturing of lab-on-a-chip devices : characterizing seals for on-board reagent delivery</i>	MechE	2013	
Saber	Aabed Saud	<i>Manufacturability of lab on chip devices : reagent-filled reservoirs bonding process and its effect on reagents flow pattern</i>	MechE	2013	
Nguyen	Khanh Huy	<i>Hot embossing as a method for rapid prototyping microfluidic devices</i>	MechE	2013	
Ragosta	Nicholas Hiroshi	<i>Design and measurement analysis of hot embossing system for high aspect ratio microfluidics</i>	MechE	2013	
Kalsekar	Viren Sunil	<i>Design and process optimization of a hot embossing machine for microfluidics with high aspect ratios</i>	MechE	2013	
Xue	Elise	<i>Sensorless ultrasound probe 6DoF pose estimation through the use of CNNs on image data</i>	EECS	2018	
DiAndreth	Christopher	<i>Optimization of downstream supply chain product flow based on an integrated cost-to-deliver perspective</i>	LGO	2019	
Cherna	Samuel	<i>External virbarion on Butterfly Probes</i>	EECS	2022	expected
Sawant	Nilay Sanjay	<i>Tenative: ML for Process Control</i>	MechE	2022	expected
Othman	Mohamed Ayman Mohamed	<i>Tenative: ML for Process Control</i>	MechE	2022	expected

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Sardet	Maele Jade	<i>Tenative: ML for Process Control</i>	MechE	2022	expected
Li	Rui	<i>Tenative: Design and Manufacture of Education Kit</i>	MechE	2022	expected
Rojrungrasithorn	Tanach	<i>Tenative: Design and Manufacture of Education Kit</i>	MechE	2022	expected
Levi	Aviva Jesse	<i>Tenative: Design and Manufacture of Education Kit</i>	MechE	2022	expected
Bradley	Russel	<i>Tenative: Design and Manufacture of Education Kit</i>	MechE	2022	expected
Smith	Carly Madeleine	<i>Tenative: Clinical Trial Monitoring Kit Design</i>	MechE	2022	expected
Aitmbiriq	Imane	<i>Tenative: Clinical Trial Monitoring Kit Design</i>	MechE	2022	expected
Noh	Joyce	<i>Tenative: Clinical Trial Monitoring Kit Design</i>	MechE	2022	expected
Lin	Ryan Shao-Wei	<i>Tenative: Clinical Trial Monitoring Kit Design</i>	MechE	2022	expected

Doctoral Theses, Supervisor					
Ljubicic	Dean	<i>High Speed Instrumentation for Inspection of transparent parts</i>	MechE	2013	
Gilbertson	Matthew Wright	<i>Electromechanical systems to enhance the usability and diagnostic capabilities of ultrasound imaging</i>	MechE	2014	
Sun	Shih-Yu	<i>Ultrasound probe localization by tracking skin features</i>	EECS	2014	
Zakrzewski	Aaron	<i>Arterial blood pressure estimation using ultrasound</i>	MechE	2017	
Roberts	Megan	<i>Design and fabrication of a flexible membrane ultrasound transducer</i>	MechE	2018	
Lee	John Haeseon	<i>Measuring the absolute concentration of particles in suspension using high frequency B-mode ultrasound imaging</i>	EECS	2015	
Fincke	Jonathan Randall	<i>Non-contact quantitative imaging of limbs, bone and tissue, using ultrasound tomographic techniques</i>	MechE	2018	
Ranger	Bryan	<i>Ultrasonic imaging methods for quantitative musculoskeletal tissue assessment and improved prosthetic interface design</i>	HST	2018	
Kundu	Ina Annesha Kundu	<i>Imaging skin structures for health, body mapping, and identification (under the Tucson Skin)</i>	MechE	2018	
Kim	David Donghyun Kim	<i>Design and development of desktop fiber and fabric manufacturing system for advanced materials</i>	MechE	2020	
Wang	Jenny Wang	<i>Formation Process of Acoustophoretic Patterns</i>	MechE	2022	

Theses Supervised by Brian W. Anthony

Pigula	Anne Pigula	<i>Statistical analysis of ultrasound signals for tissue characterization : the Homodyned K Distribution</i>	HST	2020	
Zhang	Xiang Zhang	<i>Non-contact ultrasound</i>	MechE	2019	
Benjamin	Alex Benjamin	<i>3D organ property mapping using freehand ultrasound scans</i>	MechE	2020	
Singh	Robin Singh	<i>Integrated bio-photonic devices : sensors, imagers, and beyond</i>	MechE	2021	
Chen	Melinda Chen	<i>Tentative: Liver Vascular Health Imaging</i>	HST	2022	expected
Chai	Lauren	<i>Tentative: Radiation Force Manufacturing</i>	MechE	2022	expected
Zubajlo	Rebecca Zubajlo	<i>Tentative: Physical Measurement of Cells</i>	MechE	2022	expected
Jaffe	Alex	<i>Tentative: Venous and Blood Pressure in the extremities</i>	EECS	2022	expected
Lange	April	<i>Tentative: Volume US - Squishy slam</i>	MechE	2023	expected
Zhang	Zhuorui	<i>Tentative: Large Aperture Wearable</i>	MechE	2024	expected
Gao	Mingye	<i>Tentative: Integrated Photonics for Biosensing</i>	EECS	2024	expected
Hahm	Katie	<i>Tentative: Ambient Gait Analysis</i>	MechE	2023	expected
Lin	QiAn	<i>Tentative: US Path Planning</i>	MechE	2024	expected
Kang	David Ha Eun	<i>Tentative: Homomorphic Encryption and ML</i>	MechE	2023	expected
Tripathy	Soumya	<i>Tentative: Integrated Photonics for US</i>	Media	2024	expected

Doctoral Theses, Reader

Shi	Chuan	<i>Efficient buffer design algorithms for production line profit maximization</i>	MechE	2011	
Petrzelka	Joe	<i>Contact region fidelity, sensitivity, and control in roll-based soft lithography</i>	MechE	2012	
Smyth	Katherine	<i>Piezoelectric micro-machined ultrasonic transducers for medical imaging</i>	EECS	2016	
Athanassiadis	Athanasios G.	<i>Optical breakdown acoustics : transduction and sensing underwater</i>	MechE	2019	

Postdoctoral Associates and Fellows Supervised by Brian W. Anthony

Current Postdocs

<i>Name</i>	<i>Dates of Appointment</i>	<i>PhD Granting Institution</i>
Shawn Zhang	2019 -	MIT
Praneeth Namburi	2020 -	MIT

Previous Postdocs

<i>Name</i>	<i>Current Title</i>	<i>Current Employer</i>
Vannah, Bill	Scientist	Mary Free Bed Rehabilitation Hospital
Victor Lempitsky	Head of AI	Samsung
Javier J. Gonzalez	May 2013 – 2015	University of Madrid
Matthew Gilbertson	Senior Electro-Optical Engineer	Lockheed Martin
Xian, Du	Professor	UMass (2018)
David Ibarra	Professor	Monterery Tec
Micha Feigin	Research Scientist	MIT
Ian Butterworth	Biomedical Research Engineer	MIT
Carlos Castro-Gonzalez		
	Co-Founder and CEO	Leuko
Berta Martí Fuster	Head of Communications	Oncoheroes Biosciences
Bonghun (Bruce) Shin	Senior Scientist	University Waterloo
Megan Roberts	Director of Product Development	Med Tech Co.
Greg Ely	Senior Algorithm Engineer	Imaging Co.
David Kim	Scientist	Sandia Labs