

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.; AND
SAMSUNG ELECTRONICS AMERICA, INC.,
Petitioner

v.
OURARING, INC.,
Patent Owner

Case No. PGR2024-00038
U.S. Patent No. 11,874,701

**DECLARATION OF DR. BRIAN W. ANTHONY
IN SUPPORT OF PETITION FOR POST-GRANT REVIEW
OF U.S. PATENT NO. 11,874,701**

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I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Samsung” or “Petitioner”), as an independent expert in this proceeding before the Patent Trial and Appeal Board (“PTAB” or “Board”). I understand that Samsung is requesting that the Board institute a post-grant review (“PGR”) proceeding U.S. Patent No. 11,874,701 (“the ’701 Patent”) (Ex-1001), currently assigned to Ouraring, Inc., (“Patent Owner” or “PO”).

2. I am not and have never been an employee of Samsung. I am being compensated at my usual and customary rate of \$500 per hour. No part of my compensation depends on the outcome of this proceeding, and I have no other interest in this proceeding.

3. I have been asked to provide my independent analysis of the ’701 Patent in light of the prior art patents and publications cited below. I have also been asked to consider the state of the art and prior art available as of November 29, 2013. Based on the prior art discussed in this Declaration, it is my opinion that Claims 1-7, 11, 13-16, and 18-20 of the ’701 Patent are unpatentable for the reasons provided below.

A. Qualifications

4. As indicated in my *curriculum vitae* (“CV”), included as Ex-1003, I am currently a Principal Research Scientist at the Massachusetts Institute of Technology

(“MIT”). My CV includes additional information about my professional history and contains further details on my experience, publications, patents, and other qualifications to render an expert opinion. Herein, I highlight experiences relevant to the technology of the patent at issue.

5. I earned a Bachelor of Science in Engineering from Carnegie Mellon University in 1994 and a Master’s degree in Engineering from MIT in 1998. My thesis topic related to anisotropic wave guides and acoustic non-destructive testing. In 2006, I earned my Ph.D. in Engineering from MIT. My research focused on high-performance computation, signal processing, and electro-mechanical system design.

6. 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. Our first demo-product was an optical ring for human motion measurement used to capture user hand motion in order to control the user’s interaction with a computer. Many of the structural elements of our optical ring—developed a decade prior to the ’701 Patent’s earliest possible priority date—addressed the same system issues as those described and claimed in the ’701 Patent. For example, our optical ring included optical structures for light blocking, light redirection, and light capture. We estimated human hand-motion based on how that motion changed the detected light. In our application we did not try to eliminate motion artifact, we tried to measure it. In developing our

ring, we considered well-known problems such as extraneous light and motion, which are, unsurprisingly, also discussed in the '701 Patent.

7. I joined MIT in 2006 and have been 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 '701 Patent, for example, sensor devices including non-invasive biosensors.

8. In 2011, I co-founded MIT's Medical Electronic Device Realization Center ("MEDRC") and currently serve as co-director. I am also the Director Technical Operation of the Center for Clinical and Translational Research (CCTR) at the Institute of Medical Engineering & Science, and Associate Director of MIT.nano at MIT. 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 '701 Patent. For example, one current project related to this work is in laser-ultrasound imaging and tissue characterization. In this work, an eye and skin safe pulsed laser beam is directed at the body and reflected and transmitted signals are used to map internal tissue structures. In another current project, we use a patient-mounted mobile near infrared (NIR) camera to image and characterize the surface and subsurface structures of the skin. I've developed human-in-the-loop free-hand systems that precisely measure gestures and maintain the relative orientation and position of free-hand probes with respect to the patient using a combination of accelerometers, gyroscopes, and electromagnetic emitters. Our systems ensure accuracy and stability in motions and gestures and forces, enhancing the quality of diagnostic and therapeutic procedures. Additionally, we have created gesture measurement and gesture control platforms that can simultaneously image and perform precise, operator-controlled actions on patient tissue. These platforms are designed to compensate for both patient and doctor variability, ensuring consistent and accurate results even in dynamic clinical environments. I have developed force control haptic feedback devices designed for

both medical imaging and virtual simulation applications. These devices and simulation provide precise tactile feedback to the user, enabling more accurate control and manipulation during procedures. In medical imaging, the haptic feedback device enhances the user's ability to feel the force applied by the imaging probe, improving the accuracy and quality of the imaging process. This tactile feedback helps clinicians maintain the optimal pressure and positioning of the probe, resulting in clearer images and more reliable diagnostic information. For virtual simulation, the haptic feedback device allows users to experience realistic touch sensations in a simulated environment. This capability is invaluable for training and educational purposes.

9. Furthermore, my research focuses on computational instrumentation, including the development of instrumentation and measurement solutions for manufacturing systems and medical devices. Additionally, my teaching interests include the design and modeling of large-scale systems in a wide variety of decision-making domains and developing optimization algorithms and software for analyzing and designing such systems. I teach or have taught courses in Electrical Engineering, Controls, Communications, and Signal Processing, all pertinent subject matter to the '701 Patent. I teach or have taught courses in Manufacturing Engineering, Smart Manufacturing, Industrial Internet of Things, all pertinent subject matter to the '701 Patent.

10. I also co-founded the Center for Polymer Micro-fabrication at MIT. The Center's research focuses on polymer-based manufacturing processes and the large-scale commercialization of micro fluidic devices for chemical, biomedical, and photonic applications. My experience under these initiatives is directly applicable to the technology in the '701 Patent. We develop polymer-based devices and optical sensors to and use noninvasively monitoring techniques soft flexible materials during the manufacturing process.

11. I have published approximately 100 papers and have received a number of best paper and distinguished paper awards. I am a co-author of a number of papers that relate to the technology in the '701 Patent, such as:

- 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," 2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), pp. 7204-7207;
- 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, pp. 365-372;

- J. H. Lee, C. M. Schoellhammer, G. Traverso, D. Blankschtein, R. Langer, K. E. Thomenius, D. S. Boning, B. W. Anthony, “Towards Wireless Capsule Endoscopic Ultrasound (WCEU),” IEEE International Ultrasonics Symposium (IUS), Chicago, IL, 2014, pp. 734-737; and
- 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 (EMBC), pp. 1136-1139.

B. Materials Considered

12. In forming my opinions, I reviewed the following documents, in addition to others I have cited in my declaration. I also relied on my own knowledge of and experience in the field of mechanical engineering, biomedical engineering, optical engineering, the development of physiological monitoring devices such as non-invasive biosensors, sensor system design and signal processing.

Ex. No.	Description
Ex-1001	U.S. Patent No. 11,874,701 (“the ’701 Patent”)
Ex-1003	Curriculum Vitae of Dr. Brian W. Anthony

Ex-1004	Prosecution History of the '701 Patent
Ex-1005	U.S. Patent Publication No. 20120016245 to Niwa ("Niwa")
Ex-1006	U.S. Patent No. 8,954,135 to Yuen ("Yuen")
Ex-1007	U.S. Patent No. 10,303,867 to Schröder ("Schröder")
Ex-1008	Certified Translation of DE 102013012339.9 to Schröder
Ex-1009	Original DE 102013012339.9 to Schröder
Ex-1010	U.S. Patent Publication No. 2014/0244009 ("Mestas")
Ex-1011	U.S. Provisional Patent App. No. 61/768,279 to Mestas
Ex-1012	INTENTIONALLY LEFT BLANK
Ex-1013	U.S. Patent Publication No. 20120218184 to Wissmar ("Wissmar")
Ex-1014	U.S. Patent Publication No. 2010/0219989 to Asami ("Asami")
Ex-1015	U.S. Patent Publication No. 2011/0080339 to Sun ("Sun")
Ex-1016	U.S. Patent No. 9,218,058 to Bress ("Bress")
Ex-1017	U.S. Patent No. 8,031,172 to Kruse ("Kruse")
Ex-1018	INTENTIONALLY LEFT BLANK
Ex-1019	INTENTIONALLY LEFT BLANK
Ex-1020	Claim Mapping Table
Ex-1021	INTENTIONALLY LEFT BLANK
Ex-1022	INTENTIONALLY LEFT BLANK
Ex-1023	INTENTIONALLY LEFT BLANK
Ex-1024	U.S. Patent No. 4,830,014 to Goodman ("Goodman")
Ex-1025	U.S. Patent No. 6,745,061 to Hicks ("Hicks")
Ex-1026	U.S. Patent No. 7,190,986 to Hannula ("Hannula")

Ex-1027	Volker Konig et al., <i>Reflectance Pulse Oximetry – Principles and Obstetric Application in the Zurich System</i> , 14 Journal of Clinical Monitoring (Aug. 1998) (“Konig”)
Ex-1028	U.S. Patent No. 6,608,562 to Kimura (“Kimura”)
Ex-1029	Kevin K. Tremper et al., <i>Pulse Oximetry</i> , 70 Journal of American Society of Anesthesiologists, Inc. (Jan. 1989) (“Tremper”)
Ex-1030	Y. Mendelson et al., <i>A Wearable Reflectance Pulse Oximeter for Remote Physiological Monitoring</i> , Proceedings of 28 th IEEE EMBS Annual International Conference (Aug. 30-Sept. 3, 2006) (“Mendelson 2006”)
Ex-1031	Sokwoo Rhee et al., <i>Artifact-Resistant, Power-Efficient Design of Finger-Ring Plethysmographic Sensors Part I: Design and Analysis</i> , IEEE (2000) (“Rhee 2000 Part I”)
Ex-1032	Sokwoo Rhee et al., <i>Artifact-Resistant, Power-Efficient Design of Finger-Ring Plethysmographic Sensors Part II: Prototyping and Benchmarking</i> , IEEE Proceedings of 22 nd Annual EMBS Int’l Conference (July 23-28, 2000) (“Rhee 2000 Part II”)
Ex-1033	Sokwoo Rhee et al., <i>Artifact-Resistant Power-Efficient Design of Finger-Ring Plethysmographic Sensors</i> , 48 IEEE Transactions of Biomedical Engineering (July 2001) (“Rhee 2001”)
Ex-1034	U.S. Patent No. 6,699,199 to Asada (“Asada ’199”)
Ex-1035	Sokwoo Rhee, <i>Design and Analysis of Artifact-Resistive Finger Photoplethysmographic Sensors for Vital Sign Monitoring</i> , MIT (June 2000) (“Rhee Thesis 2000”)
Ex-1036	C.T. Olofson et al., <i>Machining of Titanium Alloys</i> (1965) (“Olofson”)
Ex-1037	H. Harry Asada et al., <i>Mobile Monitoring with Wearable Photoplethysmographic Biosensors</i> , IEEE Engineering in Medicine & Biology Magazine 28 (May-June 2003) (“Asada 2003”)
Ex-1038	Denisse Castaneda et al., <i>A review on wearable photoplethysmography sensors and their potential future applications in health care</i> , Int J Biosens Bioelectron (2018)

Ex-1039	U.S. Patent No. 7,468,036 to Rulkov et al. (“Rulkov”)
Ex-1040	U.S. Patent Publication No. 2006/0211924 to Dalke et al. (“Dalke”)
Ex-1041	<i>Guidelines To Enhancing The Heart-Rate Monitoring Performance Of Biosensing Wearables</i> (2014)
Ex-1042	U.S. Patent No. 4,880,304 to Jaeb et al. (“Jaeb”)
Ex-1043	Tom Lister et al., <i>Optical Properties of human skin</i> , Journal of Biomedical Optics (2012)
Ex-1044	John G. Webster, <i>Design of Pulse Oximeters</i> , CRC Press (1997)
Ex-1045	U.S. Patent Publication No. 20130211291 to Tran (“Tran”)
Ex-1046	WO 2001/017421A1 to Lindberg (“Lindberg”)
Ex-1047	WO 2011/132009 to Nyiradi (“Nyiradi”)
Ex-1048	U.S. Patent Application Publication No. 2014/0361945 to Misra et al. (“Misra”)
Ex-1049	U.S. Patent Application Publication No. 2014/0361934 to Ely et al. (“Ely”)
Ex-1050	European Patent No. 2281205 (Chen)
Ex-1051	Lawrence K. Au et al., <i>Episodic Sampling: Towards Energy-Efficient Patient Monitoring with Wearable Sensors</i> , Annual International Conference of the IEEE Engineering in Medicine and Biology Society (2009)
Ex-1052	Anastasios Petropoulos et al., <i>Flexible PCB-MEMS flow sensor</i> , Procedia Engineering 47 236-239 (2012) (“Petropoulos”)
Ex-1053	Tianjia Sun et al., <i>Wireless Power Transfer for Medical Microsystems</i> , Springer (2013) (“Sun-Wireless”)
Ex-1054	U.S. Patent Pub. No. 2014/0187160 to Prencipe (“Prencipe”)
Ex-1055	H. Ardebili and Michael G. Pecht, <i>Encapsulation Technologies for Electronic Applications</i> , William Andrew (2009) (“Ardebili”)

Ex-1056	Ciprian Ciofu et al., Injection and Micro Injection of Polymeric Plastics Materials: A Review, Int’l J. Modern Mfg. Techs. 49 (2013)
Ex-1057	Richard J. Ross, LCP Injection Molded Packages—Keys to JEDEC 1 Performance, IEEE, 2004 Electronic Components and Technology Conference 1807 (2004)
Ex-1058	Tadamoto Sakai, Encapsulation Process for Electronic Devices Using Injection Molding Method, 12 Advances in Polymer Technology 61 (1993)
Ex-1059	N.J. Teh et al., Embedding of Electronics within Thermoplastic Polymers using Injection Moulding Technique, IEEE, 2000 Int’l Electronics Manufacturing Technology Symposium 10 (2000)
Ex-1060	U.S. Patent No. 6,201,698 to Hunter (“Hunter”)
Ex-1061	U.S. Patent No. 4,012,629 to Simms (“Simms”)
Ex-1062	INTENTIONALLY LEFT BLANK
Ex-1063	INTENTIONALLY LEFT BLANK
Ex-1064	INTENTIONALLY LEFT BLANK
Ex-1065	INTENTIONALLY LEFT BLANK
Ex-1066	INTENTIONALLY LEFT BLANK
Ex-1067	Chao Chen and Carlos Pomalaza-Raez, Monitoring Human Movements at Home Using Wearable Wireless Sensors, Proceedings of ISMICT (2009) (“Chen 2”)
Ex-1068	Christoph Amma et al., Airwriting Recognition Using Wearable Motion Sensors, Proceedings of Augmented Human Conference, Megève, France (2010) (“Amma”)
Ex-1069	Yinghui Zhou et al., Analysis and Selection of Features for Gesture Recognition Based on a Micro Wearable Device, Int. J. Adv. Computer Sci. & Appls., Vol. 3 No. 1, 1-7 (2012) (“Zhou”)
Ex-1070	Taiwoo Park et al., E-Gesture: A Collaborative Architecture for Energy-efficient Gesture Recognition with Hand-worn Sensor and

	Mobile Devices, SenSys '11, Seattle, WA (2011) (“Park”)
Ex-1071	Jun Rekimoto, GestureWrist and GesturePad: Unobtrusive Wearable Interaction Devices, Proc. 5th Int. Symposium on Wearable Computers (2001) (“Rekimoto”)
Ex-1072	H. Ying et al., Automatic Step Detection in the Accelerometer Signal, 4th Int. Workshop on Wearable and Implantable body Sensor Networks, Springer (2007) (“Ying”)
Ex-1073	Chun Zhu and Weihua Sheng, Wearable Sensor-Based Hand Gesture and Daily Activity Recognition for Robot-Assisted Living, IEEE Trans. Systems, Man, and Cybernetics, 41(3) (2011) (“Zhu”)
Ex-1074	Jiayang Liu et al., uWave: Accelerometer-based Personalized Gesture Recognition and Its Applications, Pervasive and Mobile Computing 5(6), 657-75 (2009) (“Liu”)
Ex-1075	Thomas Schlömer et al., Gesture Recognition With a Wii Controller, Proc. 2d Int. Conf. Tangible & Embedded interaction, Bonn, Germany (2008) (“Schlömer”)
Ex-1076	Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, The MIT Press, Cambridge, Massachusetts (2012) (“Murphy”)
Ex-1077	Paulo Trigueiros et al., A Comparison of Machine Learning Algorithms Applied to Hand Gesture Recognition, 7th Iberian Conf. Inf. Syst. & Techs. (2012) (“Trigueiros”)

II. LEGAL STANDARDS

13. In forming my opinions and considering the subject matter of the '701 Patent and its claims in light of the prior art, I am relying on certain legal principles that counsel in this case explained to me. My understanding of these concepts is summarized below

14. I understand that earlier publications and patents may act to render a patent unpatentable for one of two reasons: (1) anticipation, and (2) obviousness.

A. Anticipation

15. As explained to me by counsel, it is my understanding that the claims of a patent are anticipated by a prior art reference if each and every element of the claim is found either explicitly or inherently in the reference. I understand that inherency requires a showing that the missing descriptive matter in the claim is necessarily present in the allegedly anticipating reference, and that it would have been so recognized by a person of ordinary skill in the art (“POSITA”).

16. I understand that when a challenged claim covers several structures, either generically or as alternatives, the claim is deemed anticipated if any of the structures within the scope of the claim is found in the prior art reference.

17. Although anticipation typically involves the analysis of a single prior art reference, I understand that additional references may be used to show that the prior art reference has enabling disclosure (i.e., allows a POSITA to make the invention without undue experimentation), to explain the meaning of a term used in the prior art reference, and/or to show that a characteristic is inherent in the prior art reference.

B. Obviousness

18. As explained to me by counsel, I understand that a claim is invalid as obvious if it would have been obvious to a person of ordinary skill in the art at the time the alleged invention was made. This means that even if all of the elements of the claim cannot be found in a single prior art reference that would anticipate the claim, a person of ordinary skill in the art who was aware of the prior art would have been able to come up with the claimed invention. This may be the case, for example, where the missing element represents only an insubstantial different over the prior art or a reconfiguration of a known system. I understand that in an obviousness determination, the person of ordinary skill in the art is presumed to have knowledge of all material prior art.

19. I understand that an obviousness analysis requires an understanding of the scope and content of the prior art, any differences between the alleged invention and the prior art, and the level of ordinary skill in evaluating the pertinent art.

20. I understand that when a product is available, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill in the art can implement a predictable variation, obviousness likely bars its patentability. For the same reason, if a technique has been used to improve one device and a person of ordinary skill in the art would

recognize that it would improve similar devices in the same way, using the technique would have been obvious.

21. I understand that whether a prior art reference renders a patent claim unpatentable as obvious is determine from the perspective of a person of ordinary skill in the art at the time of the alleged invention. I have been told that there is not requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, but a suggestion to combine known elements to achieve the claimed invention may come from the prior art, as filtered through the knowledge of one skilled in the art. In addition, I have been told that the inferences and creative steps a person of ordinary skill in the art would employ are relevant to the determination of obviousness.

22. I understand that one may consider, e.g., whether (1) the change was merely the predictable result of using prior art elements according to their known functions, or whether it was the result of true inventiveness; (2) there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; (3) the claimed innovation applies a known technique that had been used to improve a similar device or method in a similar way; (4) the claimed invention would have been obvious to try, meaning that the claimed innovation was one of a relatively small number of possible approaches to the problem with a reasonable expectation of success by those skilled in the art; (5) the

invention merely substituted one known element for another known element in order to obtain predictable results; (6) the invention merely applies a known technique to a known device, method, or product to yield predictable results; or (7) known work in one field of endeavor may have prompted variations of it for use in either the same field or a different one based on design incentives or other market forces that would have been predictable to a person of ordinary skill in the art.

23. I further understand that certain factors may support or rebut the obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of the invention, unexpected results of the invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I understand that there must be a nexus—that is, a connection—between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

24. I am not aware of any allegations by the named inventors of the '701 Patent or any assignee of the '701 Patent that any secondary considerations tend to rebut the obviousness of the '701 Patent.

25. Additionally, I understand that in considering obviousness, it is important not to use the benefit of hindsight derived from the patent under consideration.

C. Indefiniteness

26. As explained to me by counsel, I have been informed and understand that a patent claim is indefinite and therefore invalid if the claim, read in light of the patent specification and the prosecution history, fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. I understand that claims must particularly and distinctly set out what is claimed so that the public has fair notice of the claimed invention. I also understand that each term in a claim must find clear support or antecedent basis in the specification.

D. Level of Ordinary Skill in the Art

27. When interpreting a patent, I understand that it is important to identify the relevant art pertaining to that patent, as well as the level of ordinary skill in that art at the time of the claimed invention. The “art” is the field of technology to which the patent is related.

28. I am informed and understand that the POSITA is a hypothetical person who is presumed to know the relevant prior art. I understand that the actual inventor’s skill is not determinative of the level of ordinary skill. I further understand that factors that may be considered in determining level of skill include:

(i) the types of problems encountered in the art; (ii) prior art solutions to those problems; (iii) the rapidity with which innovations are made; (iv) the sophistication of the technology; and (v) the educational level of active workers in the field. I understand that not all such factors may be present in every case, and one or more of them may predominate.

29. I understand that a POSITA is one who is presumed to be aware of all pertinent art, thinks along conventional wisdom in the art, and is a person of ordinary creativity.

30. A person of ordinary skill in the art at the relevant time, which I have been told to consider as of November 29, 2013 (“POSITA”) would have had at least a four-year degree in electrical engineering, mechanical engineering, biomedical engineering, optical engineering, or related field of study, or equivalent experience, and at least two years’ experience in academia or industry studying or developing physiological monitoring devices such as non-invasive biosensors. A POSITA would have also been familiar with, e.g., sensor system design, including inertial and other motion sensor system design, signal processing, and human-machine interfaces. A higher level of education or skill might make up for less experience, and vice versa.

31. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of a person of ordinary skill in the relevant art. For example, from

my industry experience, I am familiar with what an engineer engaged in sensor system design (using, e.g., non-invasive biosensors and/or inertial and other motion sensors) would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possessed the knowledge of a POSITA myself at least as of 1997.

E. Claim Construction

32. I understand that the United States Patent and Trademark Office interprets claim terms in an *inter partes* or post-grant review proceeding under the same claim construction standard that is used in a United States federal court. I understand that under this standard, the meaning of claim terms is considered from the viewpoint of a POSITA at the time of the alleged invention.

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

34. I understand that in addition to the claims, specification, and prosecution history, other evidence may be considered to ascertain the meaning of claim terms, including textbooks, encyclopedias, articles, and dictionaries. I have

been informed that this other evidence is often less significant and less reliable than the claims, specification, and prosecution history.

III. SUMMARY OF GROUNDS

Ground	Summary
1	Claims 1-7, 11, 13-16, and 18-20 are obvious in view of US 2011/0080339 (“Sun,” Ex-1015).
2	Claims 4 and 17 are obvious over Sun in view of US 8,031,172 (“Kruse,” Ex-1017)
3	Claims 1, 6-7, and 13-20 are obvious in view of Kruse
4	Claims 2-5, and 11 are obvious over Kruse in view of Sun
5	Claim 6 is invalid under 35 U.S.C. § 112 as indefinite

IV. THE ’701 PATENT

A. Overview of the ’701 Patent

35. The ’701 Patent relates to a wearable smart ring. Ex-1001, Abstract. The ring includes an accelerometer, which “can measure gestures performed by a user while wearing the [ring].” *Id.*, 8:64-66. In this manner, the ring “can be used to perform one or more commands, or to instruct another device, such as a mobile device, to perform one or more commands.” *Id.*, 25:22-31.

36. As part of a “training mode,” the ring can be programmed to recognize new gestures performed by the user:

In some embodiments, **the WCD 110 can also be programmed to learn particular gestures** or physical exercise from the user using, for example, a training mode. For example, the user can instruct (e.g., using

a computer or a mobile device of the user) the WCD 110 to enter the training mode and perform the gesture or physical exercise; **the WCD 110 can record the readings from the sensor modules 220, recognize patterns therefrom, and store the result** in, for example the memory 260, **so that such gesture or exercise can be recognized by the WCD 110 after the training.**

Id., 9:27-36.¹ As part of this training mode, the user can assign the new gestures to functions through a mobile application running on a mobile device:

The WCD 110 can be configured (e.g., **via a mobile application** running on a mobile device of the user) so that **the recognized gestures can perform functions designated.**

Id., 36-40. The '701 Patent explains that this training may involve the user “perform[ing] the custom gesture multiple times”:

The user can establish one or more custom gestures to initiate ... commands []. For example, the user can select a command to be customized from a number of commands. Once selected, the user can perform a custom gesture to be associated with that command. In some examples, **the user can perform the gesture multiple times** to allow the WCD to better identify the gesture and to develop error tolerances for registering the gesture.

Id., 25:31-38.

37. In a navigation mode (as illustrated in Figure 18A, reproduced below), the ring receives heading information from a mobile device executing a map application, and “can give feedback to the user regarding the actual heading measured by the onboard magnetometer and the heading set forth in the direction

¹ Throughout, emphasis and annotations are added unless otherwise specified.

information.” *Id.*, 20:55-21:2. The ’701 Patent explains that this feedback “can be haptic or physical feedback provided by one or more actuators.” *Id.*, 20:67-21:2.

38. The ’701 Patent describes this embodiment (as illustrated in Figure 18A, reproduced below), as follows:

[T]he heading provided by the mobile device is the heading 2335, which represents the direction in front of the hand position 2330. In this regard, if the user gestures, e.g., points a ring finger, in the direction of the correct heading, **the WCD 2300 can give feedback to the user indicating the correct heading. The feedback can include, for example, an LED indicator 2310 showing a green visible light.** In the example of hand position 2320, the finger is gesturing in a direction to the left of the correct course 2325. In this way, **the WCD 2300 can provide feedback to correct the heading of the user. Such feedback can include illumination of an LED indicator showing (e.g.) a red visible light.** Similarly, hand 2340 is gesturing in direction 2345, which is to the right of the correct/appropriate direction. The WCD can provide (e.g.) a blue indicator informing the user to change heading.

Id., 21:3-21.

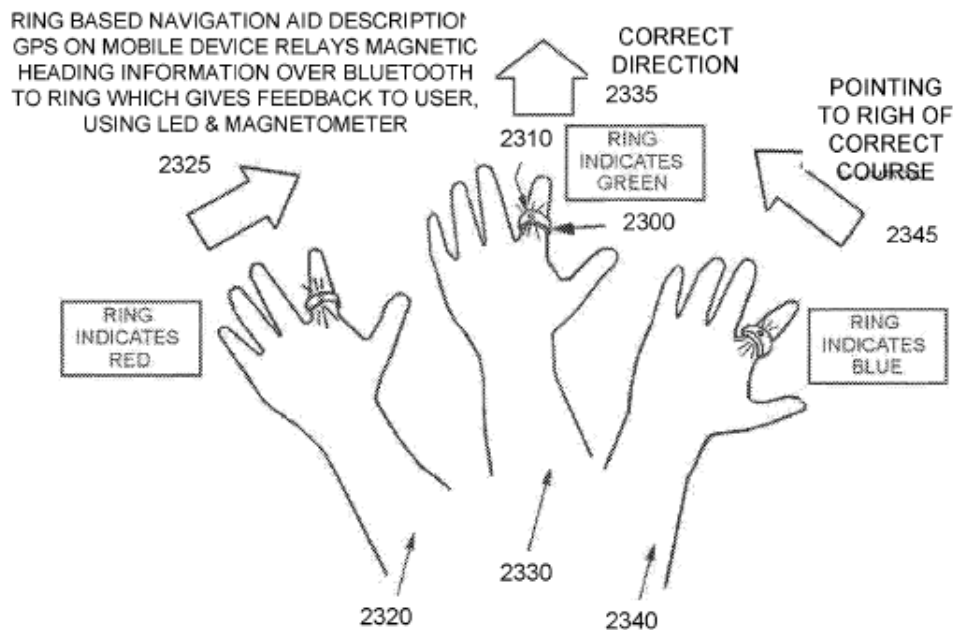


FIG. 18A

39. The challenged claims are directed to a “wearable electronic device” configured to identify gestures performed by the users, match the identified gestures to stored gesture patterns, and, based on the matching, “provide feedback to the user” or “transmit a signal” to control an external device.

40. As I discuss in further detail below, the challenged claims are obvious over prior art describing the same capabilities.

B. Prosecution History of the '701 Patent

41. The '701 Patent was filed March 6, 2023, and claims priority through a series of continuation and divisional applications to Provisional App. No. 61/910,201 filed November 29, 2013. Ex-1001, Cover. The as-filed application included a single claim, which was rejected on the basis of statutory double-

patenting. Ex-1004, 0042-0047, 0861. The applicant amended the application by heavily revising that claim and adding current claims 2-20. *Id.*, 0030-0038. These claims were allowed without rejection. *Id.*, 0011-0017. The '701 Patent issued January 16, 2024. Ex-1001, Cover.

42. I understand that my Declaration presents arguments and prior art not considered during prosecution of the '701 Patent.

V. TECHNOLOGY BACKGROUND

A. Wearable Electronic Devices Were Known

43. Wearable electronic devices, along with the various design challenges they posed and the solutions proposed to address these challenges, were well-known to a POSITA by 2013. For example, it was known by 2013 that wearable photoplethysmographic biosensors could be used for the monitoring, diagnosis, and treatment of major and chronic diseases “by providing information enabling precise titration of therapy or detecting lapses in patient compliance.” Ex-1037, 28 (Asada 2003). Wearable biosensor devices were known to be useful in “sensing untreated elevated blood pressure” and “trigger[ing] an automated reminder for the patient to take...medication.” Ex-1037, 28 (Asada 2003); *see also* Ex-1030, 912 (Mendelson 2006) (“[T]he emerging development of compact, low-power, small-size, light-weight, and unobtrusive wearable devices may facilitate remote noninvasive monitoring of vital signs[.]”).

44. Wearable electronic devices in the form of a finger-ring structure were also known by 2013. For example, Harry Asada and his group at MIT developed a ring sensor by 2003 that was “capable of reliably monitoring a patient’s heart rate, oxygen saturation, and heart rate variability.” Ex-1037, 28 (Asada 2003); *see also* Ex-1034, 1:20-24 (Asada ’199) (“Finger-ring sensors may be employed, for example, for monitoring such physiological parameters as blood flow, blood constituent concentration, and pulse rate, all of which may be measured by other means that are more cumbersome, and thus less comfortable, to a patient.”), 2:51-56 (“For purposes of the present description, the sensor will be referred to, without limitation, as a ring sensor, and the sensing modality, again without limitation, will be described in terms of a photoplethysmographic device for measuring a pulse using optical elements such as infrared light-emitting diodes (LEDs) and photodiodes.”). The prototypes of Asada’s finger-ring as of 2003 are depicted below. Ex-1037, Figs. 9-10, 15 (Asada 2003).



Fig. 9. First prototype ring sensor with RF transmitter powered by a coin-size cell battery.

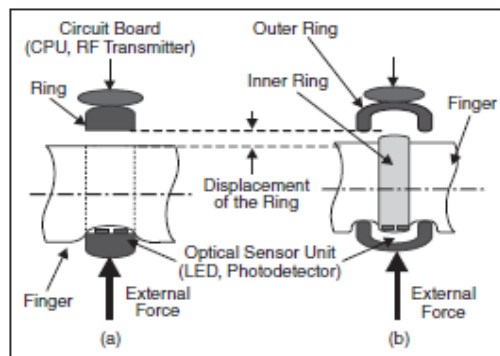


Fig. 10. Dislocation of ring sensors due to external load. (a) Traditional single-body design under external force. (b) New isolating double ring sensor under external force [31].

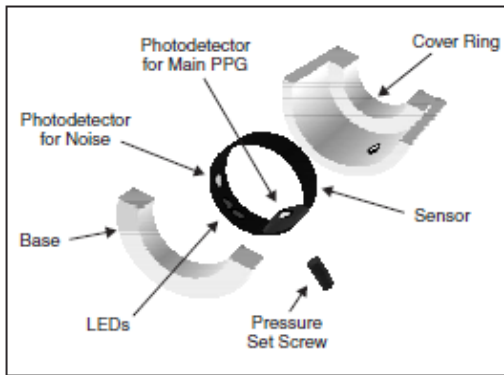


Fig. 15. The schematic of the Prototype C ring sensor.

45. Asada explains the motivations for implementing a wearable electronic device in the form of a ring, noting that “[c]ompactness, stability of signal, motion and other disturbance rejection, durability, data storage and transmission, and low power consumption” are “major design considerations.” Ex-1037, 28 (Asada 2003). He further notes that “[i]t is imperative that they are simple to use and comfortable to wear for long periods of time.” Ex-1037, 28 (Asada 2003). Moreover, he explains that “[s]ince continuous monitoring requires a device that must be noninvasive and worn at all times, a ring configuration for the sensor unit is a natural choice” because of its “low weight and small size,” and “rings are generally worn without removal more often than watches.” Ex-1037, 28 (Asada 2003). He also notes that recent studies “indicated that the finger is one of the best places for WBS sensor attachment” because “[t]he primary vasculature of the finger is located near the surface and therefore makes it optimal for monitoring arterial blood flow using noninvasive optoelectronic sensors,” thus making it “ideal for long-term measurements.” Ex-1037, 30 (Asada 2003); *see also* Ex-1034, 1:20-24 (Asada ’199)

(“A sensor worn as a finger ring sensor has particular advantages since a ring sensor may be worn by the patient at all times, hence the health status may be monitored 24 hours a day.”).

46. Asada explains that “[a]n obvious source of signal corruption results from the direct interaction of the sensor unit with the wearer’s surrounding environment; e.g., holding objects, touching surfaces, etc.” Ex-1037, 34 (Asada 2003). Therefore, “the body of the ring must separate the sensor unit in order to decouple the sensor unit from these interactions.” Ex-1037, 34 (Asada 2003). He therefore designed and implemented “a double ring configuration” such that “[t]he disturbance force is born by the outer ring and is not transmitted to the inner ring holding the sensor unit” and “the outer ring serves as an optical shield for protecting the sensor unit from the ambient light.” Ex-1037, 34 (Asada 2003).

47. Asada and his group also built and field-tested a transmittal photo-plethysmograph (“PPG”) ring sensor “[t]o improve motion artifact resistance and accuracy.” Ex-1037, 35 (Asada 2003). He redesigned a sensor band using “bio-compatible elastic materials to better hold the LED[s] and PD[s], maintain a proper level of pressure, optically shield the sensor unit, and secure the contact with the skin consistently in the face of finger motion,” resulting in a stable transmittal PPG. Ex-1037, 35 (Asada 2003); *see also* Ex-1028, 1:13-16 (Kimura) (“This invention relates to a vital signal detecting apparatus for detecting a vital signal, having an

attachable device to be attached for example to a finger, an ear, an arm, a leg, torso or a neck of a human subject.”).

48. Harry Asada’s graduate student, Sokwoo Rhee, also authored a thesis and a number of articles between 2000 and 2001 detailing the design, analysis, prototyping, and benchmarking, of finger-ring plethysmographic sensors. *See, e.g.*, Ex-1031 (Rhee 2000 Part I); Ex-1032 (Rhee 2000 Part II); Ex-1033 (Rhee 2001); Ex-1035 (Rhee Thesis 2000). Specifically, Rhee developed and presented “[a] miniaturized, telemetric, photoplethysmography sensor for long-term, continuous monitoring,” called “a ‘ring-sensor,’” which “is attached to a finger base for monitoring beat-to-beat pulsation, and the data is sent to a host computer via a RF transmitter.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 795 (Rhee 2001); Ex-1035, 14 (Rhee Thesis 2000). “The ring sensor is a miniaturized, telemetric, monitoring device worn by a patient as a finger ring.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1035, 14 (Rhee Thesis 2000) (same); Ex-1033, 796 (Rhee 2001) (“This miniaturized sensor in a ring configuration is a rational design choice for 24-h continuous monitoring, since a finger ring is probably the only thing that a majority of people will be willing to wear at all times.”).

49. Rhee’s thesis and papers address two major design issues: “one is to minimize motion artifact and the other is to minimize the consumption of battery power.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1033, 795 (Rhee 2001); Ex-1035, 2

(Rhee Thesis 2000). “An efficient double ring design is developed to lower the influence of external force, acceleration, and ambient light, and to hold the sensor gently and securely on the skin, so that the circulation at the finger may not be obstructed.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1033, 795 (Rhee 2001); Ex-1035, 2 (Rhee Thesis 2000). The structural details of Rhee’s finger-ring sensor are discussed in more detail in the sections below.

1. Photoplethysmography (PPG) sensors were well known

50. A plethysmograph is a device used to measure changes in volume within the body or a specific organ. This measurement can be applied in various medical contexts to monitor and diagnose conditions related to blood flow, respiratory function, and other physiological parameters.

51. One specific type of plethysmograph is the photo-plethysmograph (PPG), which utilizes optical techniques to detect blood volume changes in the microvascular bed of tissue. PPG devices typically use a light source and a photodetector to measure the variations in light intensity as it is transmitted through or reflected off the tissue. These variations are caused by the pulsatile nature of blood flow, hence the name “plethysmograph,” referring to the measurement of volume changes.

52. Photoplethysmography (PPG) is a well-known optical measurement method for monitoring heart rate. Ex-1038. Popularity around using PPG

technology as an alternative to heart rate monitoring techniques have increased “due to the simplicity of its operation, the wearing comfort ability for its users, and its cost effectiveness.” *Id.*, 0002. Wearable PPG sensors can be placed at the body locations shown in Figure 1. *Id.*, 0003, 0014.

53. PPG uses “a light source and a photodetector at the surface of skin to measure the volumetric variations of blood circulation.” *Id.*, 0001. “The light source emits light to a tissue and the photodetector measures the reflected light from the tissue.” *Id.*, 0003. Atypical PPG sensors emit light to “detect cardiovascular diseases.” *Id.*, 0005. The most common LED colors used are red and green while some studies have also used yellow. *Id.* PPG also utilizes “infrared light to measure the volumetric variations of blood circulation” which provides information about the user’s cardiovascular system. *Id.*, 0002. Near-infrared light can also be used for early detection of physiological parameters such as cardiovascular diseases. *Id.* This is because “[l]ight with longer wavelengths penetrates more deeply into the tissue.” *Id.*, 0005. However, infrared light is more susceptible to motion artifacts caused by “movement of the PPG sensor over the tissue, skin deformation, blood flow dynamics, and ambient temperature.” *Id.* In that instance, green LEDs have a shorter wavelength and may be a better option. *Id.* Thus, a POSITA would have understood it would have been beneficial to use both visible LEDs and infrared LEDs to gather various physiological data helpful to the user.

2. Beer's Law

54. Beer's Law describes the relationship between the absorbance of light by a substance and its concentration. The equation is: $A = \epsilon \cdot b \cdot c$. Where: (A) represents the absorbance of light. (ϵ) is the molar absorptivity (a constant specific to the substance). (b) is the path length (the distance the light travels through the sample). (c) is the concentration of the absorbing substance.

55. Beer's law "describes the attenuation of light traveling through a uniform medium containing an absorbing substance." Ex-1044 (WebsterDesign), 0054, Fig. 4.1. "Pulse oximeters determine the oxygen saturation of arterial blood by measuring the light absorbance of living tissue at two different wavelengths and using the arterial pulsation to differentiate between absorbance of arterial blood and other absorbers." *Id.*, 0058. For example, when light from LEDs enters the tissue, it is scattered by both the moving red blood cells and the nonmoving tissue, and a part of this back scattered light is detected by the photodiode. *Id.*, 0102. The output of the photodiode is processed by the pulse oximeter and measures the oxygen saturation of the pulsatile blood. *Id.*

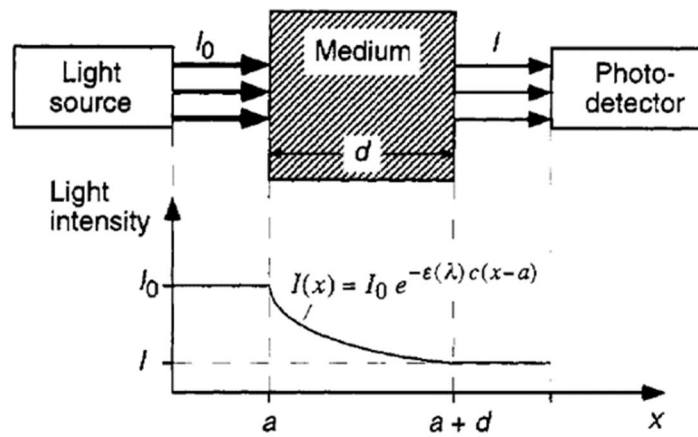


Figure 4.1 Beer's law: Incident light of intensity I_0 travels the distance a from a light source to the medium without being absorbed in the air. The light intensity decreases exponentially with distance in the absorbing medium. The intensity of the transmitted light I is determined by Beer's law. It stays constant after exiting the medium with optical path length d and can be measured by a photodetector.

56. The measured amount of oxygen in the blood differ from the results of the Beer's law theory because Beer's law does not assume light scattering but light scattering highly increases the absorbance of light. *Id.*, 0066. The skin surface, tissue, muscle, bone, and blood of the user causes light scattering which increases the absorbance of light. *Id.*, 0065. The intensity of the light scattered by the tissue “depends on such factors as the red blood cell concentration in the blood; on the size, shape, orientation, and index of refraction of the scattering particles; on the tissue thickness; and on the aperture cone of the detector.” *Id.*, 0066. Further, the scattering effects of the light passing through blood depend on the wavelength of the light and the oxygen saturation. *Id.*, 0067.

3. Optical properties of human tissue

57. There are two biomolecules considered to dominate the absorption of visible light in skin: hemoglobin and melanin. Ex-1043 (Optical Properties), 0001. Hemoglobin is the dominant absorber of light in the dermis. *Id.* Melanin is a family of biomolecules that provide pigment to skin. *Id.*, 0001, Fig. 1. Melanin is generally contained within the “epidermis and produce[s] an absorption spectrum that gradually decreases from the ultraviolet (UV) to the infrared (IR) regions.” *Id.*, 0001. The optical properties of this layer result in absorption and scattering of light, which are characterized by the absorption and scattering coefficients. *Id.*, 0003. The absorption coefficient “characterizes the average number of absorption events per unit path length of photons traveling in the tissue.” Ex-1041 (Guidelines to enhancing), 0002. The absorption coefficient can also be calculated as a function of wavelength.

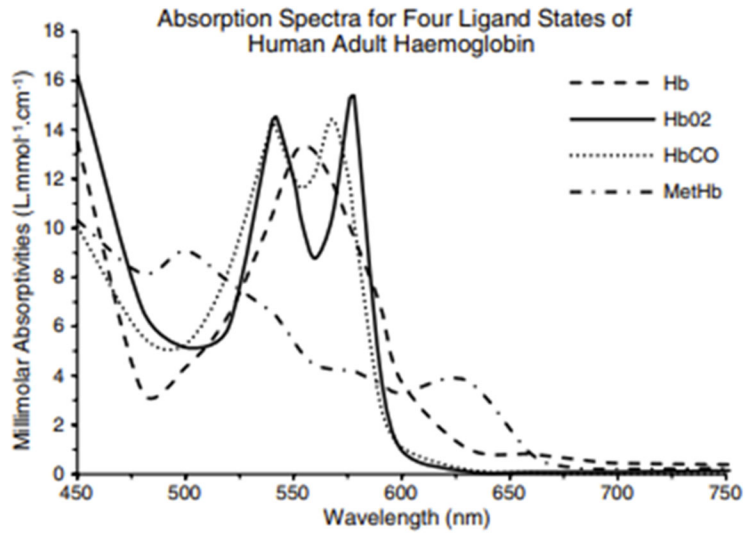


Fig. 1 Absorption spectra of deoxyhemoglobin (Hb), oxyhemoglobin (HbO₂), carboxyhemoglobin (HbCO), and methemoglobin (MetHb) in the visible region, from Ref. 27.

58. As shown in Figure 1, the peak absorption coefficients correspond to wavelengths around 540nm and 570nm. *Id.*, 0003. At the wavelength of around 540nm and 570nm, “the absorption change due to the blood volume change is the greatest and the photodiode measures the strongest pulsate signal.” *Id.*

4. Pulse oximetry and oxygen saturation (SpO₂)

59. Pulse oximetry measures peripheral arterial oxygen saturation (SpO₂) as an indicator of tissue oxygenation. How it works: Light at two different wavelengths (for example, 660 nm and 940 nm) illuminates oxygenated (oxyhemoglobin) and deoxygenated hemoglobin (deoxyhemoglobin) in blood. The ratio of light absorbance between these two forms of hemoglobin is calculated. This

ratio is compared with previously calibrated direct measurements of arterial oxygen saturation (SaO_2) to estimate peripheral SpO_2 .

60. The calculation of arterial oxygen saturation (SpO_2) using a PPG involves analyzing the photoplethysmograph signal, which comprises both alternating current (AC) and direct current (DC) components. The AC component represents the pulsatile part of the signal, corresponding to the cardiac cycle, while the DC component represents the non-pulsatile part, including constant tissue and venous blood absorption.

61. To calculate SpO_2 , the ratio of the AC to DC components of the PPG signal at two different wavelengths (typically red and infrared) is used. This ratio is indicative of the relative absorption of light by oxygenated hemoglobin (Oxy-Hb) and deoxygenated hemoglobin (Deoxy-Hb). By comparing these ratios at the two wavelengths, the proportion of Oxy-Hb to Deoxy-Hb can be determined.

62. The formula for calculating SpO_2 is derived from this ratio, often expressed as: $\text{SpO}_2 = (\text{Oxy-Hb}) / (\text{Oxy-Hb} + \text{Deoxy-Hb}) \times 100\%$.

5. Transmission of light as compared to the reflection of light

63. Light interacting with tissue at the microscale (wavelength scale) undergo absorption, reflection, or transmission.

64. Pulse oximetry devices, used to measure SpO_2 , are designed to operate at the macroscale or sensor scale (emitter and detector scale) and are generally

described as operating in two modes: transmission mode and reflection mode.

Transmission Mode: In this mode, the light emitter and the detector are generally positioned on opposite sides of the tissue. Light from the emitter penetrates the tissue and takes a general path that passes through the tissue to the opposite side of the tissue, and the detector measures the light that has traversed the tissue.

Reflection Mode: In this mode, both the light emitter and the detector are generally positioned on the same side of the tissue. Light from the emitter penetrates the tissue and takes a general path that passes through the tissue and back to the same side of the tissue, and the detector measures the light that has traversed the tissue.

65. From the perspective of light transmission through the tissue bed, there is no difference between these two modes. Once a photon has traveled a sufficient distance to lose its history (less than 1 mm in tissue for pulse oximetry wavelengths), it becomes irrelevant whether the detector is positioned opposite the emitter or on the same side. This is because, after traveling this distance, the photon's interactions with the tissue have caused it to diffuse in such a way that its path is randomized, and light is absorbed along whatever path the light takes.

66. Reflectance and transmission are best considered as practical design and manufacturing terms. They describe the physical arrangement of the emitters and detectors rather than any fundamental difference in the measurement process. Both geometries are used to measure the diffused absorption of light through a

blood-perfused tissue bed, providing essential information about blood oxygen saturation levels.

67. Whether in transmission or reflection mode, pulse oximeters measure the same optical phenomena: the interaction of light with the blood and tissues. This interaction is key to determining oxygen saturation, as it relies on the differential absorption characteristics of oxygenated and deoxygenated hemoglobin

6. Multiple LEDs have been commonly used for biometric monitoring

68. Using multiple LEDs is beneficial to offset noise effects of ambient light and sunlight in real-time vital sign monitoring devices. For example, U.S. Patent No. 7,468,036 to Rulkov et al. (“Rulkov”) recommends a “greenlight LED and a pulsed infrared LED to offset noise affects of ambient light and sunlight.” Ex-1039, 6:56-58. Rulkov also uses multiple LEDs of green and infrared wavelengths, with a preferred embodiment in which the optical sensor includes “a plurality of light emitting diodes” (“LED”) based on green light, and further describes monitoring vital signs in which “the plurality of light emitting diodes comprises a plurality of pulsed infrared light emitting diodes.” *Id.*, 6:49-58. A POSITA would have understood that multiple emitters each including multiple LEDs operating at different wavelengths advantageously provide “accurate” “real-time information to

the user about the user's health" by, for example, enabling offset of noise affects. *Id.*, 4:4-8.

69. U.S. Patent Publication No. 2006/0211924 to Dalke et al. ("Dalke") also discloses the use of multiple spaced-apart LEDs operating at various wavelengths and/or intensities. Ex-1040. Dalke states "there can be any number of LED groups and any number of LEDs within a group" and further that such LEDs "may be grouped according to output intensity or wavelength or both." Ex-1040 ¶ 75.

7. Separation distance between LEDs and the photodiode is a design consideration for the quality of the acquired data

70. From a system design and performance perspective, determining the ideal separation distance between the LEDs and photodiode is important. To enhance the quality of the plethysmogram signal one method includes placing the photodiode close to the LEDs. Ex-1041 (Guidelines to enhancing), 0005. However, if the photodiode is too close to the LEDs, the photodiode becomes saturated by measurements that do not relate to the heart signal of the user. *Id.* To have a constant LED intensity, "the total light detected by the photodiode decreases roughly exponentially as the radial distance between the LEDs and the photodiode is increased." *Id.* Thus, placing the photodiode farther apart from the LEDs can result in a plethysmogram with a larger signal that relates to the heart signals of the user.

Id. As an example, U.S. Patent No. 4,880,304 to Jaeb et al. (“Jaeb”) uses this method and resolves the problem of low signal strength by placing its LEDs 16 and 18 in a radial pattern around detector 20 that detects the light of the LEDs. Ex-1042, 5:6-8.

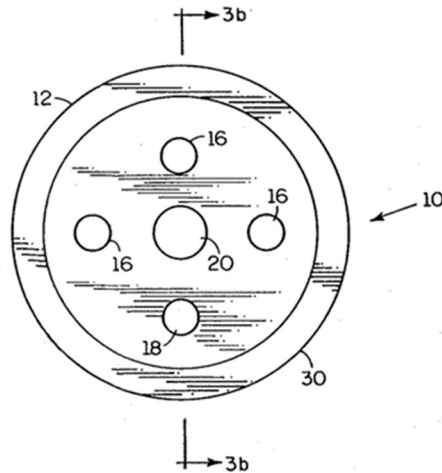


FIG. 3a

B. Wearable Electronic Device Arrangements

71. In view of the various applications that wearable electronic devices can be used, there are various considerations that a POSITA must consider when designing a wearable electronic device. I have summarized only a few considerations of the electronic device arrangements below.

1. Wearable devices having inner and outer surfaces were Known

72. Finger-ring structures having inner and outer surfaces with electronics housed inside within a cavity were known. For example, Rhee’s thesis and papers

teach a finger-ring sensor having inner and outer surfaces. Specifically, Rhee teaches, as shown in Figure 1 (Rhee 2000 Part II) and Figure 3 (Rhee 2001) below, that an “inner ring floats inside the outer ring” such that “[w]hen a patient wears the ring, both rings are put on the same finger.” And, “[s]ince the outer ring covers the inner ring, the external force is born by the outer ring and does not directly act on the inner ring.” Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 799 (Rhee 2001); Ex-1035, 68 (Rhee Thesis 2000) (same).

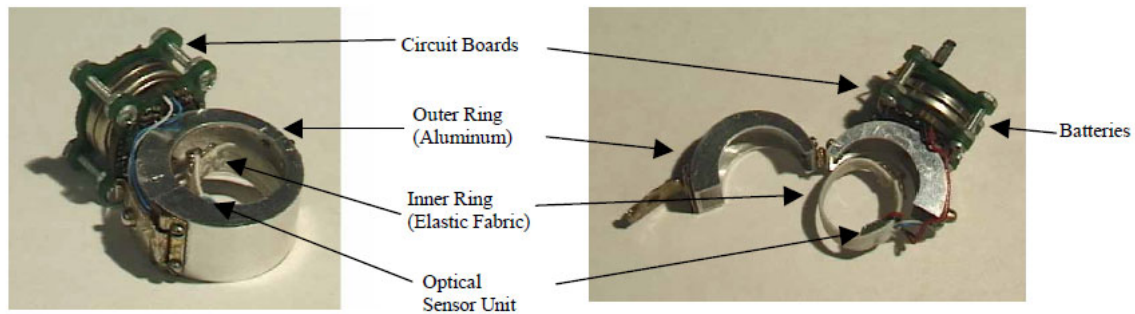


Figure 1 : Isolating ring sensor designed for motion artifact minimization

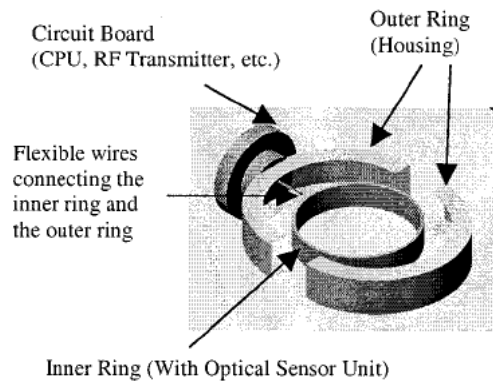


Fig. 3. Construction of isolating ring.

2. Various ways to assemble electronic parts within structural cavities were known

73. The formation of cavities, whether by single-structure formation or multi-structure assembly techniques, is essential for integrating electronic components, cabling, batteries, PCBs, and assemblies into the interiors and exteriors of mechanical surfaces, structures, and frames. This is crucial in the manufacturing of electromechanical devices ranging from cars and computer interface devices to phones, toys, watches, electronic medical devices, and other modern battery or wall-power operated devices. Manufacturing and assembly approaches vary based on tooling sizes, costs, and complexities.

74. Most objects seen in everyday life are non-planar. Therefore, it is necessary that the electronic systems fit a convenient form factor of the shape into which it will be integrated.

75. Creating a mechanical part from raw material involves bulk material removal, forming cavities or holes, and finishing to meet specifications. Techniques like milling, drilling, and EDM are commonly used and were widely known as of 2013. For difficult-to-machine materials, processes such as electro-discharge machining, laser beam machining, electron beam machining, shaped tube electrochemical machining, and electrochemical spark machining are employed and were known in 2013. To meet stringent micro- to nanometer range requirements,

advanced finishing techniques like abrasive flow machining, magnetic abrasive finishing, magnetic float polishing, magneto-rheological abrasive finishing, and ion beam machining have been developed.

76. For the integration of electrical circuits into products, the use of electronics flexible systems as inserts to replace traditional rigid substrates in injection molding machines has become common.

77. Common Techniques include:

- a. Machining for Metals: Milling, drilling, EDM, and additive manufacturing.
- b. Formation for Plastics: Molding and thermoforming.
- c. Chip and PCB Packaging Techniques: Incorporating methods from semiconductor and PCB manufacturing.

78. There are many examples in the art of ways that electronics could have been assembled within a wearable electronic device by 2013. For example, U.S. Patent No. 4,830,014 to Goodman teaches that the light source and the photosensor may be mounted to substrates using “sequential layers of surgical tape, opaque vinyl, and light filters” and “constructed of such small dimensions that both independently conform with a low aspect ratio to the flexible adhesive strip.” Ex-1024, 6:10-21 (Goodman).

79. Further, by 2013 it was well understood that in order to house electronic components within wearable devices, there must be an internal space like a cavity within the mechanical, or structural, elements. From a manufacturing and assembly perspective, a cavity can either be premade, with electronic components subsequently assembled and attached into it, or the electronic components themselves can be used to define the cavity during a molding process. Either approach ensures efficient integration of electronics into wearable devices, accommodating their compact and functional design requirements. For example, U.S. Patent Application Publication No. 2012/0218184 to Wissmar (Ex-1013), teaches electronic components “located in a cavity within the electronic finger ring.” Ex-1013 ¶28. Wissmar’s finger ring is a toroidal shaped finger ring structure made with “two different metallic shells: (i). 1 a, made of gold (Au) or silver (Ag), enclosing the major parts of the finger ring structure geometrically described as radially furthest away from the toroid’s centre, and (ii). 1 b, made of a titanium compound (Ti, TiW), being the metal enclosing facing the inner parts of the finger ring structure.” *Id.* ¶73. As shown below in Figure 1, the “toroidal shaped finger ring structure 1 is comprised of different electronic components: a battery 2, a RF transceiver 3 and a micro processor 4, a microstrip line 5, an accelerometer 6, an internal antenna 7, a pressure sensor 8; all mounted on a flexible printed circuit board 9. In this embodiment, there is also an outer metal shell opening 10 serving as an RF

window letting through unperturbed RF radiation.” *Id.* ¶73. The components shown in Figure 1 are housed within the cavity in the electronic finger ring.

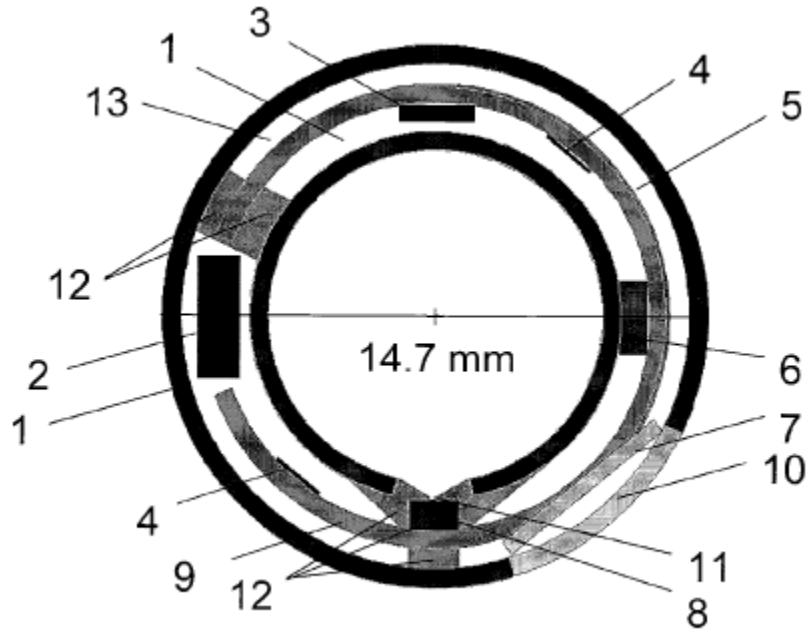
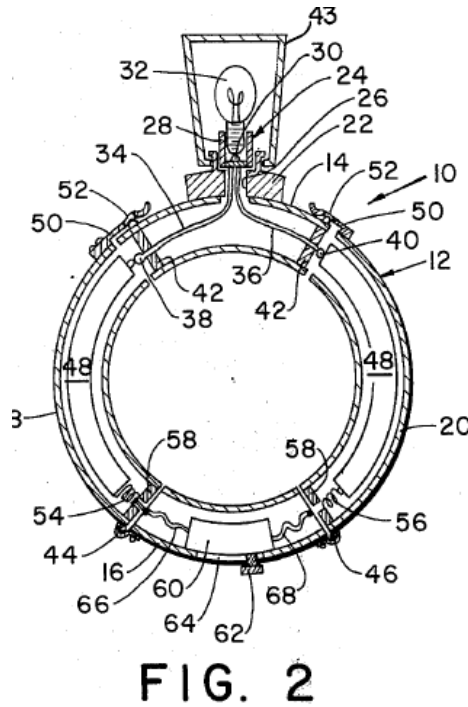


Fig. 1

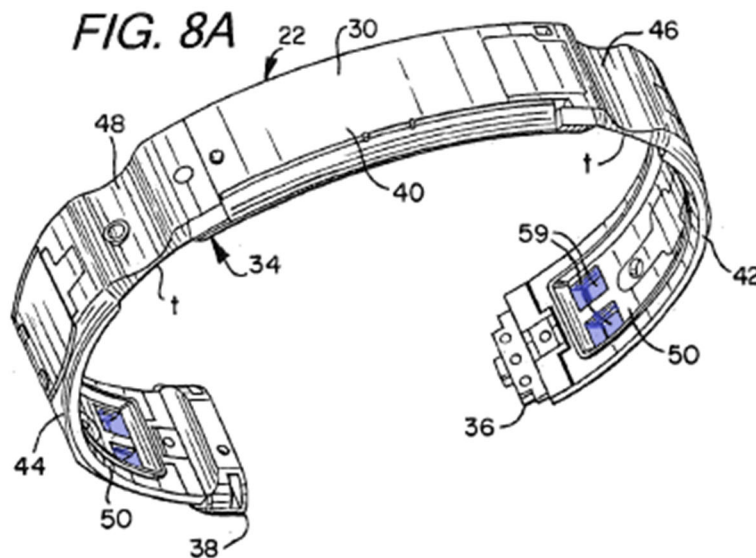
80. Similarly, U.S. Patent No. 6,201,698 to Hunter teaches that “the side walls and the web together create a cavity [] to house the electronic circuit.” Ex-1060, 2:56-57.

81. U.S. Patent No. 4,012,629 to Simms also teaches a flashlight ring that includes “a hollow toroidal finger encircling member formed in four sectors” with each sector having its own electronic components inside. Ex-1061, Abstract.



82. Moreover, U.S. Patent Publication No. 20140244009 to Mestas teaches an electronic wearable device that has “compartments” for its electronic components. Mestas’s device has “compartments for power supplies, an outer encasement member 24, and a fastening mechanism 26 or latch member 26.” Ex-1010 ¶151; *see also id.* ¶183 (“light member compartment 180”). Further, Mestas explains that the batteries are inserted into the battery compartments. *Id.* ¶157. For example, as shown in Figure 8A, the “recessed compartments 50, 52 are dimensioned to receive power supplies associated with the controller 14 . compartments 50, 52 further have a pair of openings 59 to receive battery terminals or contacts to be described. The recessed compartments 50, 52 may vary in size generally or with respect to one another. Thus, the recessed compartments 50, 52

may have an increased size to accommodate larger power supplies having increased capacity.” *Id.* ¶156. “The batteries are positioned in the recessed compartments 50, 52 wherein the contacts 150 extend through the openings 59 in the compartments 50, 52 and engage the PCB member 140 to provide power to the device 10.” *Id.* ¶168. Therefore, it was well known to have compartments, or voids, inside a wearable electronic device in order to house specific electronic components.



83. Encapsulating electronics within a cavity of a structural element by, for example, injection molding, was well known by 2013. *See, e.g.,* Ex-1055, Ex-1056, Ex-1057, Ex-1058, and Ex-1059. I discuss this in more detail below in Section V.C.

84. Housing electronic parts within one component or between two components was known. For example, U.S. Patent No. 6,699,199 to Asada teaches that “one or more photo diodes 2 and one or more light-emitting diodes (LEDs) 4

are imbedded in a ring 10.” Ex-1034, 2:59-61 (Asada '199). Moreover, U.S. Patent No. 6,745,061 to Hicks teaches that “[i]ncluded within the assembly 350 are upper and lower flexible members 304 and 300, respectively,” which are “thermally bound to one another sandwiching a leadframe 308 between their inside surfaces.” Ex-1025, 6:48-54 (Hicks). “This leadframe 308 contains active components (i.e., LEDs and a photodetector) for use in oximetry measurements.” Ex-1025, 6:48-54 (Hicks).

85. Electronic parts housed within a structural cavity in an electronic device could include, for example, microcontrollers, batteries, and RF communication components. For example, Rhee’s thesis and papers teach a ring sensor that included “optoelectronic components, a CPU, a RF transmitter, a battery, and a ring chassis,” wherein the “optoelectronic components, i.e. microphotodiodes and LEDs, detect the blood volume waveforms and oxygen saturation level at the patient’s digital artery. The CPU controls the LED lighting sequence as well as the data acquisition and transmission process. These signals are locally processed by the on-board CPU and transmitted to a host computer for diagnosis of the patient’s cardiovascular conditions.” Ex-1031, 1 (Rhee 2000 Part I); Ex-1032, 2796 (Rhee 2000 Part II) (“The basic circuit configuration of the ring sensor is a standard photoplethysmographic circuit combined with a wireless transmitter. There are a single photodiode and LEDs of two different wavelengths, red and near infrared, involved in the circuit. ... The two channels of digital signals are transmitted via a

RF transmitter. ... “[T]he whole system is designed and operated for low-power consumption. ... Each component has to be selected for low-power consumption and the whole system must be operated for minimum power consumption. The microprocessor coordinates the whole operation so that reliable measurement is performed with minimum power. ... The main circuit board and batteries, which are heavy and bulky in comparison to the sensor unit, sit on the outer ring.”); Ex-1033, 796-97, 799, Fig. 1 (Rhee 2001) (same); Ex-1035, 14, 21-22, 68 (Rhee Thesis 2000) (same).

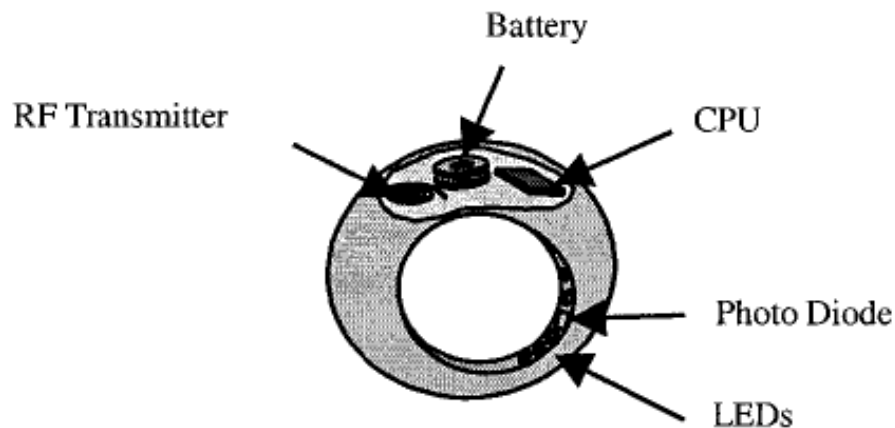


Fig. 1. Conceptual diagram of the ring sensor.

86. Moreover, Harry Asada and his MIT team by 2003 developed a finger-ring prototype having an “optical sensor unit, analog and digital processing units, and an RF transmitter, all of which are encapsulated in a compact body and powered by a tiny cell battery used for wristwatches”; and a PIC microcomputer for

performing device controls and signal processing including “LED modulation, data acquisition, filtering, and bi-directional RF communication.” Ex-1037, 34 (Asada 2003); *see also* Ex-1034, 3:12-21 (Asada ’199) (“Referring now to FIG. 2, a cross-section is shown of finger ring sensor 20 as worn on finger 22 of a patient. In preferred embodiments of the invention, a sensor band 21 is worn in direct contact with the finger and holds one or more Detector S2 and 26, against the skin of the finger. sensor band 21 is encompassed by base ring 23 which, in turn, is encompassed by cover ring 25 which supports circuit module 29 containing battery 12, processor 6, and transmitter 8, all shown in FIG. 1, and serves also to shield detectors 2 and 26 from ambient light.”).

87. It was also known by 2013 that electronics in a wearable electronic device could be assembled at the bottom of the device (i.e., away from the skin surface). For example, the Konig reference teaches that, in transmission pulse oximetry “[t]he optical elements are located on the opposite sides of a body part” and “[t]he sensors are applied mainly to the fingers and toes.” Ex-1027, 405 (Konig).

3. Attaching electronics to a surface within an electronic device was known

88. A POSITA would have understood by 2013 that electronics should be attached to a surface in the device and that where that attachment occurs (for example, at the top or bottom of a cavity) would have been a matter of design choice.

As an example, Harry Asada and his group at MIT state that “transmittal PPG configurations do not have the short circuit problems” of reflective PPGs because “the LED and PD are placed on the opposite sides of the finger” (i.e., at the bottom surface) such that “no direct path through the air can be created.” Ex-1037, 31 (Asada 2003). This type of design allows the use of “devices having a weak polarity, which is, in general, more robust against disturbances.” Ex-1037, 31 (Asada 2003). Moreover, transmittal PPGs are also “less sensitive to local disturbances acting on the finger, since the LED irradiates a larger volume of the finger.” Ex-1037, 31 (Asada 2003). Importantly, Asada notes that “[d]esign trade-offs must be considered to find the best modulation scheme.” Ex-1037, 32 (Asada 2003).

89. Rhee’s thesis and papers teach, as shown in Figure 2 below, that in an original design (a) the “optoelectronic sensor unit, i.e. the LEDs and photodiodes, is attached directly to the body of the ring.” Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 796 (Rhee 2001); Ex-1035, 17 (Rhee Thesis 2000). Rhee notes that the problems with that design were fluctuations in the sensor reading, displacement of the ring relative to the skin surface, and difficulty shielding the sensor unit from ambient lighting. Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001). “To resolve these problems of the original ring design, a new design” was developed, called an “isolating ring configuration” (b), which “separate[s] the sensor unit from the rest of the ring body that is much heavier than the optical sensor unit alone.” Ex-1031, 2

(Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001); Ex-1035, 17 (Rhee Thesis 2000).

“The separation is achieved by having two rings that are mechanically decoupled to each other,” wherein “[t]he inner ring holds sensor unit alone, while the outer ring contains the CPU, signal processing unit, battery, and RF transmitter” and “[o]nly a thin, flexible cable connects the two rings.” Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001). Rhee teaches that the advantages of this design are that it alleviates the influence of external forces applied to the ring (because the outer ring bears the force not the sensor unit on the inner ring), it alleviates the effect of acceleration on the sensor, reduces skin pressure, and reduces ambient lighting influence. Ex-1031, 2 (Rhee 2000 Part I); Ex-1033, 797 (Rhee 2001). Rhee additionally teaches that “[a] miniaturized sensor unit is attached to the inner ring whose mass is almost negligible,” which is “a small circuit board ... contain[ing] two light emitting diodes and a photodetector.” Ex-1032, 2796 (Rhee 2000 Part II); Ex-1033, 799 (Rhee 2001); Ex-1035, 68 (Rhee Thesis 2000).

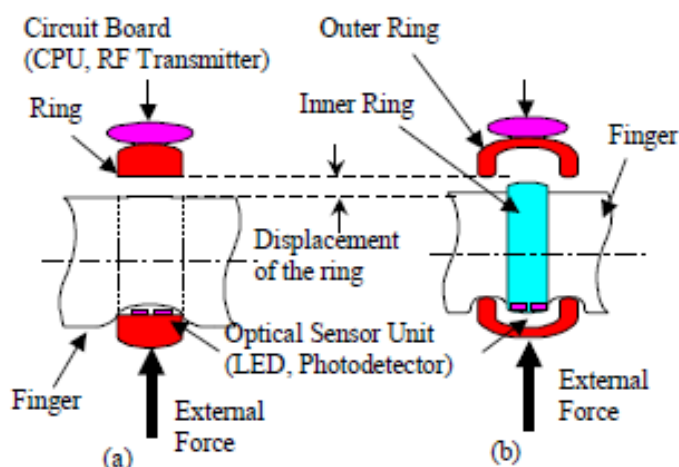


Figure 2 : Dislocation of ring sensors due to external load
(a) Traditional single body design under external force
(b) New isolating ring sensor under external force

90. There are also examples in the prior art where electronics were attached to the bottom surface. For example, U.S. Patent No. 6,608,562 to Kimura states that “[t]he photo diode 23 is disposed at the bottom of the inside of the attachable device 1 where it can receive the returning light.” Ex-1028, 6:60-62 (Kimura). U.S. Patent No. 6,745,061 to Hicks also states that “[m]ounted on a top surface of the clear flexible substrate is at least one active pulse oximetry component,” which includes “at least one light emitter, such as a light emitting diode, and/or a light detector, such as a photodiode.” Ex-1025, 2:12-18 (Hicks). “Particularly, these active components are mounted on the top surface of the clear substrate such that they emit/detect light through the clear substrate and its bottom surface.” Ex-1025, 2:12-18 (Hicks); *see also* Ex-1025, 2:31-32 (Hicks) (noting that “the bottom surface of the clear flexible substrate” is “the patient side of the sensor,” which means that the “top surface of

the clear substrate” would be the side that is away from the patient’s skin (what the ’833 Patent refers to as the “bottom” of the cavity)), 10:15-17 (“The traces 70-76 of the present embodiment are formed on the top surface of the clear substrate 80 using a conductive ink (e.g., epoxy with silver).”).

4. Flexible and rigid-flex printed circuit boards were well-known

91. Wearable electronic devices and sensors often present space, weight, and geometry constraints in the design, manufacturing, and placement of their electronic components. To address such constraints, the electronics can be placed on flexible printed circuit boards (“PCBs”), which were well-known by 2013.

92. Flexible PCBs are made from materials such as Kapton, which are used due to their thermal stability, mechanical flexibility, and electrical insulation properties. These properties enable them to conform to various shapes and endure bending and flexing during manufacturing assembly and use while maintaining their digital or analog circuit functionality. Their flexibility is essential in applications requiring the PCB to adapt to non-flat surfaces without compromising the electronic performance. For example, Petropoulos describes the fabrication of a flexible PCB made of Kapton foil, which exhibits lower thermal conductivity (thus better thermal insulation) and is much thinner than a regular, rigid PCB. Ex-1052, 237 (Petropoulos).

93. By 2013, flexible PCBs and arrangements of flexible and rigid PCB (“rigid-flex” PCBs) were widely utilized in wearable electronic devices. For example, U.S. Patent No. 8,954,135 to Yuen teaches a wearable biosensing device where its light source(s) and/or associated detector(s) are disposed on a Flat Flex Cable or “FFC” or flexible PCB. In this embodiment, the flexible or pliable substrate (for example, FFC or flexible PCB) could connect to a second substrate (for example, PCB) within the device having other components disposed thereon (for example, the data processing circuitry.” Ex-1006, 12:35-42 (Yuen). This flexible structure allows the inner, “skin-side” surface of the device to conform or adapt to the shape of the user’s body (for example, arm, wrist, ankle or leg) that the device is secured to so that there is “little to no gap between the skin side of the device and the juxtaposed surface of the skin of the user.” Ex-1006, 12:24-42 (Yuen). Similarly, U.S. Patent No. 10,303,867 to Schröder teaches a flexible PCB, but teaching that electronics such as antenna coil and a chip module in its biosensing “finger-ring” are applied on a “carrier foil” that “consists of a flexible plastic material, e.g. PET or Kapton,” through technologies such as a printing technique. Ex-1007, 12:27-37, 13:23-37 (Schröder). U.S. Patent Pub. No. 2014/0244009 to Mestas also teaches the use of flexible and rigid-flex PCBs in its wearable electronic biosensing device, where the electronics are disposed on a spine member “having substantially rigid portions and certain flexible portions or zones.” Ex-1010, ¶¶151,

153 (Mestas). Mestas further teaches that a rigid-flex printed circuit board (PCB) is wrapped onto the spine of the device and similarly includes rigid zones (annotated dark purple below) connected by flexible zones (light purple) for placing the various electronic components. *Id.*, Figs. 14, 15, ¶¶164, 177 (Mestas). The decision to utilize a rigid, flexible, or rigid-flex PCB is driven and balanced by an evaluation of the trade-offs between costs and benefits and system-design decision for an entire device.

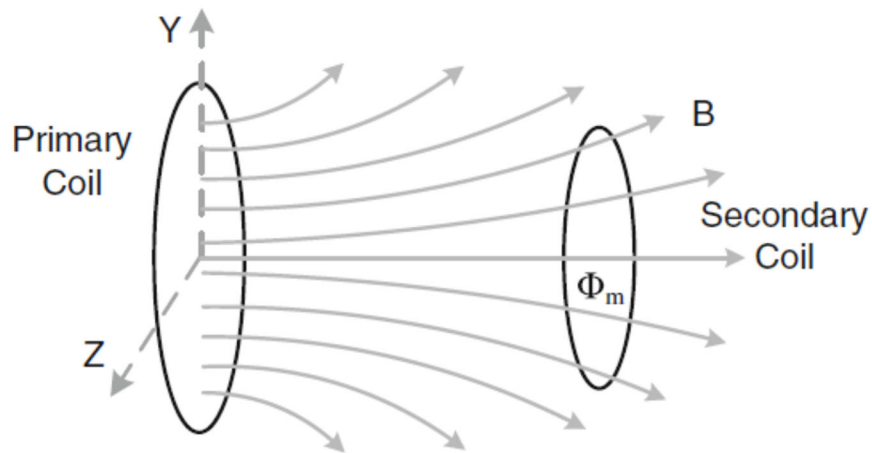
5. Wireless inductive charging was well-known

94. The benefits of wireless charging batteries powering electronic devices, in particular wearable electronic devices, were well known by 2013.

95. As noted in T. Sun's *Wireless Power Transfer for Medical Microsystems* book from 2013, "wireless power transfer (WPT) . . . was invented over 100 years ago." Ex-1053, 1 ("Sun-Wireless"). By 2013 wireless power transfer was used either for "real-time energy" or "to charge batteries" in biomedical devices. *Id.*, 140 (Sun-Wireless). Near-field (as opposed to long-distance) wireless power transfer can be one of two types: inductive coupling or capacitive coupling. *Id.*, 5, Fig. 1.4 (Sun-Wireless). While capacitive coupling relies on capacitors, inductive coupling, which Sun notes is the "best choice for biomedical app[lications]," relies on coils. *Id.*, Fig. 1.6 (Sun-Wireless). As Sun further explains, "[t]he most well-

known power antenna for biomedical applications is the magnetic inductive coil.”
Id., 42 (Sun-Wireless).

96. Inductive coupling relies on magnetic flux coupling between a coil of a primary power transmitter and a coil of a secondary power receiver, which are not physically connected. *Id.*, 19 (Sun). The coil and its connected electronics on the receiving side picks up the time-varying magnetic field created by the coil on the transmitting side, thus transferring electromagnetic power wirelessly. *Id.*, 19, Fig. 2.2 (reproduced below).



97. Besides its use in biomedical devices, induction charging was also widely used by 2013 for charging batteries of wearable electronic devices and many types of cordless consumer devices. For example, U.S. Patent Pub. No. 2014/0187160 to Prencipe teaches a wireless communication enabled smart ring with a “battery [that] is rechargeable by any suitable recharging method, including but not limited to induction (e.g., from a charging station or from ambient

electromagnetic radiation). Ex-1054 ¶36 (Prencipe). Similarly, Mestas teaches a wearable athletic device that “may be configured for re-charging batteries via induction charging.” Ex-1010 ¶201 (Mestas). Similarly, Schröder teaches a biometric sensing “finger-ring” with a battery that “is preferably charged by means of [an] electromagnetic field,” using an antenna coil. Ex-1007, 11:46-67 (Schröder).

C. Wearable Electronic Device Materials

1. Machinability of metallic materials was known

98. Materials such as metals including titanium were known to be machinable by 2013. For example, Olofson’s Machining of Titanium Alloys book from 1965 states that “[t]oday, tools and techniques are available for machining titanium efficiently.” Ex-1036, 1 (Olofson). “In fact, some machining operations give more consistent results on titanium than they do on some grades of steel.” Ex-1036, 1 (Olofson). “A bonus factor is the ease of attaining good surface finishes.” Ex-1036, 1 (Olofson). “Rms [root mean square] values as low as 20 to 30 microinches can be obtained on some titanium parts without much trouble.” Ex-1036, 1 (Olofson). Olofson’s Table 1 “shows the approximate machinability relationships between the titanium alloys and the other alloys of interest.” Ex-1036, 1 (Olofson) (comparing aluminum alloys, alloy steel, stainless steel, and titanium alloys among others).

2. Using a moldable filler material or potting material to cover electronics was known

99. Using a moldable filler material or “potting material” to cover the electronics in a device was known by 2013 including the motivations for doing so. Similar materials are suitable for both molding and potting processes in manufacturing. Both molding and potting processes require materials with attributes such as thermal stability, electrical insulation, and mechanical strength.

100. By 2013, injection molding was “the most popular method for producing plastic products because of its high productivity and the manufacturability for making various complex shapes.” Ex-1056, 51 (Ciofu). The “[i]njection process is a cyclical process, during which succession occurs following operations: dosing of plastic material; heating and melting the plastic inside the cylinder; closing the mold; placing plastic material inside the mold cavity under pressure; melt solidification and cooling; mold opening; elimination product injected.” Ex-1056, 52 (Ciofu). Moreover, “[q]uality parameters (responses) are usually associated with evaluating the replication fidelity of the processes by completely filling the mould cavity.” Ex-1056, 55 (Ciofu), 57-57 (“feature engineering that refers to filling cavities is influenced by the part geometry, size and position of point size and shape filling and filling channels”); *see also, e.g.*, Ex-1058, 61 (Sakai) (“Plastic packaging for semiconductor products such as integrated circuits (ICs) has been commercially

made by means of a transfer molding method using epoxy resin.”), 65 (applying “a quantitative analysis for molten polymer filling behavior in the cavities using a mold-filling simulation program commercially available such as Mold Flow”), 66 (“Figure 11 shows the experimental results using the 16-cavity side gate cold-runner system”), Fig. 11; Ex-1059, 10 (Teh) (“Figure 1 illustrates an example of such injection moulded thermoplastic parts with an embedded electronic subassembly. This proposed encapsulation technology adapts conventional techniques of thermoplastic injection moulding and electronic printed wiring board (PWB) assembly in order to achieve economical efficiency and manufacturing viability.”), 11 (“As shown in Figure 2, injection moulding can be briefly described as a cyclic process of forming plastic into a pre-determined geometry by forcing high-temperature plasticized or molten polymer resin under an injection pressure into a specially shaped cavity (mould).”), Figs. 1-2.

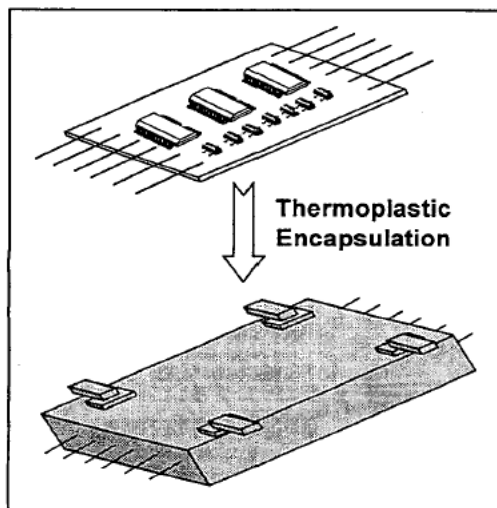


Figure 1. Illustration of the electronic overmoulding

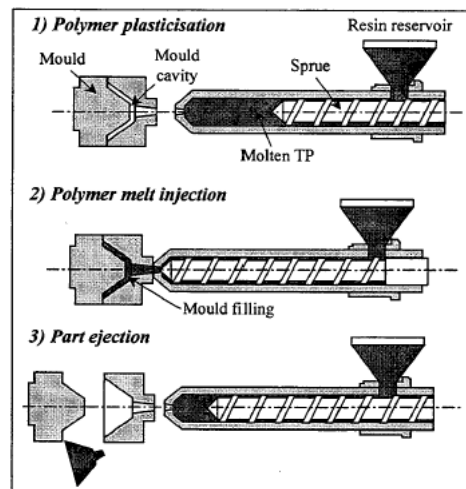


Figure 2. Schematic diagram of injection moulding

101. As Ardebili's *Encapsulation Technologies for Electronic Applications* book from 2009 explains, "[p]otting involved positioning the electrical circuit in a container and pouring the liquid encapsulant into the cavity." Ex-1055, 3 (Ardebili). "Common materials used for potting . . . of electronic units are silicones, epoxies, and polyurethanes." *Id.*, 90. A related encapsulation technique, "molding is a process of encapsulating microelectronic devices in a closed mold." *Id.*, 129 (Ardebili). Molding compounds include similar materials: "resins, . . . , silicones, phenolics, and BPA epoxies." *Id.*, 57 (Ardebili).

102. Ardebili also discusses encapsulating electronics within a cavity. *See, e.g.*, Ex-1055, 4 (Ardebili) ("The encapsulant, typically a thermosetting polymer, is cured in the cavity to form the final electronic package."), 6 ("Plastic packages can be pre-molded or post-molded. In the pre-molding process, a package base is prepared from a pre-molded plastic (or sometimes a metal substrate). The chip is then placed on the base and connected to an I/O fan out pattern with wire. A pre-molded plastic lid or housing is attached on top, using an epoxy adhesive to protect the die and wire bonds, and forms a cavity inside the package. Figure 1.5 shows a pre-molded package. Pre-molded packages are most often used for high-pin-count devices or pin-grid arrays that are not amenable to flat lead-frames and simple fan out patterns."), 31 ("Hermetic packages are cavity packages that are designed to seal against moisture and corrosive gases. They are made of materials that are highly

moisture impermeable such as ceramics and metals. A metal or ceramic lid (or housing) is welded or attached to a package base to produce the hermetic seal.”),
437 (“Figure 8.12(a) shows another example of selective encapsulation of a MEMS [micro-electromechanical system] suspension sensor chip that includes a cavity constructed on the back surface. Figure 8.12(b) shows selective plastic encapsulation of a MEMS device stacked on an IC chip. Figure 8.13 shows a selective encapsulation method for a MEMS pressure sensor from Motorola [22]. A protective dam is constructed on the outer perimeter of the pressure sensor diaphragm, thus forming a cavity between the dam and the package housing. The cavity can be filled with plastic encapsulant material. The package housing is also made of plastic material.”).

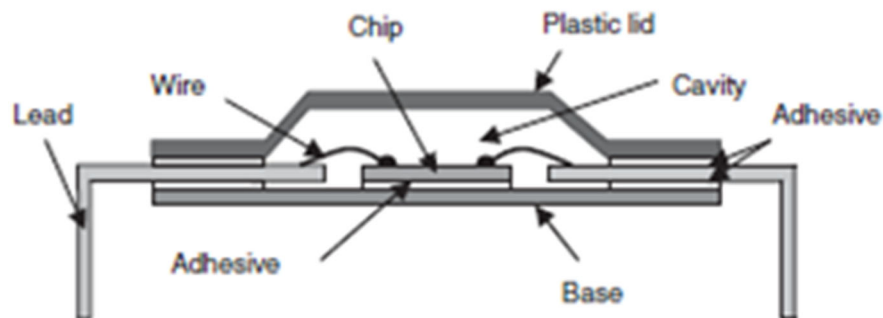


Figure 1.5 A pre-molded plastic package [9].

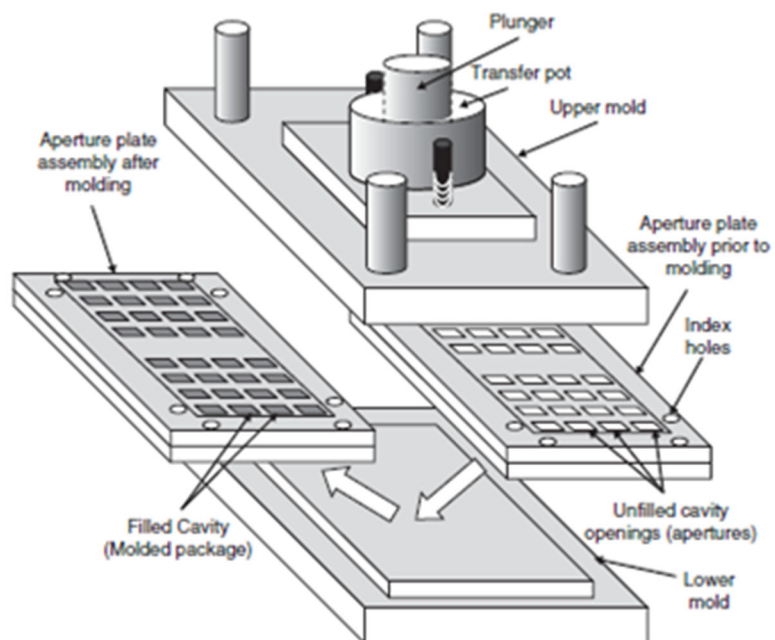


Figure 3.4 Aperture-plate (or cavity plate) molding setup [3].

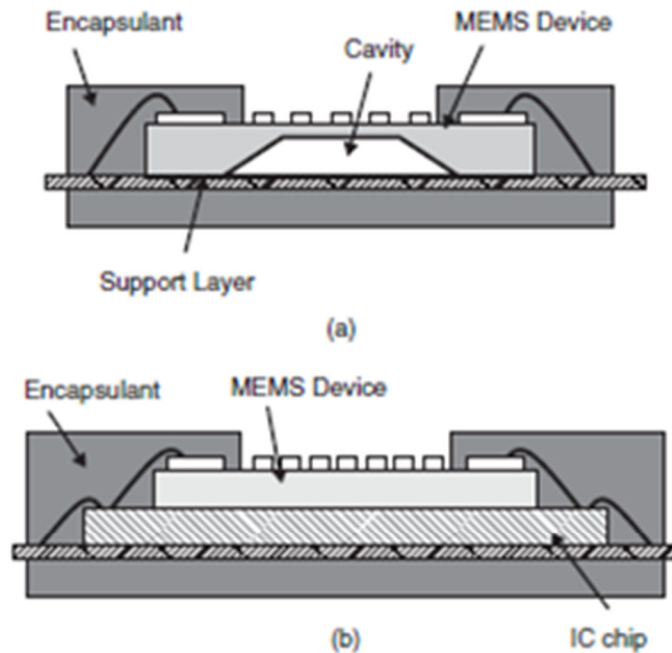


Figure 8.12 Plastic-encapsulated MEMS device package designs from Industrial Technology Research Institute: (a) MEMS device with a cavity; (b) 3D package with a MEMS device stacked on an IC chip [21].

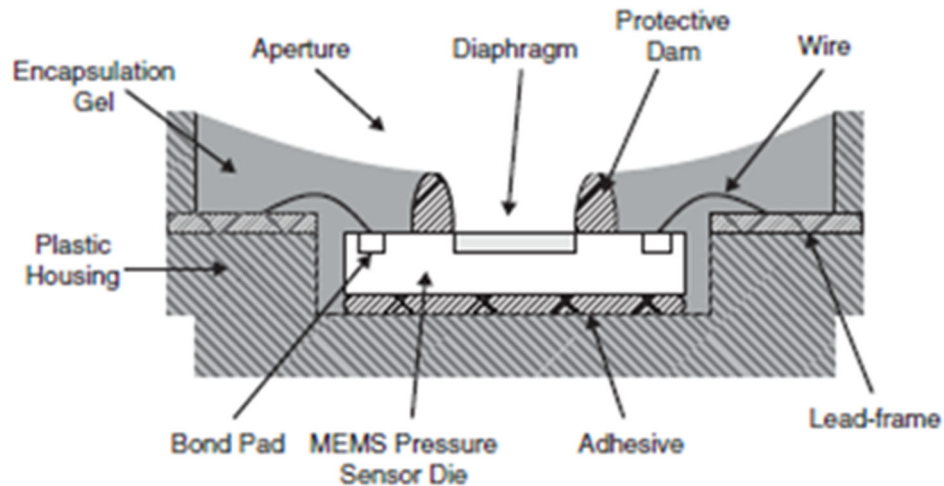


Figure 8.13 Plastic-encapsulated MEMS pressure sensor device from Motorola [22].

103. As applications of these encapsulation or coating techniques, for example, it was known that a light source and photosensor may be mounted to

substrates using “sequential layers of surgical tape, opaque vinyl, and light filters.” Ex-1024, 6:10-21 (Goodman). “Thereafter, apertured, opaque vinyl and finally a transparent adhesive layer are placed over the entire photo-sensor” resulting in “a simple flexible adhesive strip apparatus which is in conformance to the blood perfused flesh, i.e., digit being interrogated for blood flow.” Ex-1024, 6:10-21 (Goodman); *see also* Ex-1057, 1809 (Ross) (“If the package body material is not tightly adhered to the penetrating leads on all four sides there will be a direct and open moisture path to the package interior and a gas leak path to the exterior of a sealed package during gross leak testing.”).

104. The advantages of using moldable filler or potting materials to cover electronic parts include “that the blood flow of a critically compromised patient may be measured with limited risk of measurement error incurred by motion artifact; the foam layer between the adhesive and the substrate provides a tight, nonpressure exerting, skin seal which prevents motion artifact”; “the foam layer between the adhesive and the substrate provides a light-tight seal between the skin and the sensor, thus protecting the components and resulting measurement from the deleterious effects of ambient light”; and “an opaque photographic coating applied to the foam/adhesive side of the flexible substrate prevents measurement inaccuracies by diminishing light refraction and rebound.” Ex-1024, 7:32-49 (Goodman); *see also* Ex-1059, 11 (Teh) (discussing “the technological and economic implications of ...

overmoulding technology ... in the production of highly integrated polymer encapsulated electronics products”), 12 (the advantages of encapsulating electronics within structural moulding is “Reduced package size,” “Lower manufacturing costs,” “Better product durability,” “Improved system robustness,” and “Product recyclability”).

105. U.S. Patent No. 6,745,061 to Hicks (“Hicks, Ex-1025) teaches that the coating could be an epoxy or an ink. For example, Hicks states that “the flexible sensor may contain a light blocking layer applied to the top surface of the clear flexible substrate to minimize the effect of ambient light sources upon the sensor,” which “may include a separate substrate interconnected to the clear flexible substrate or some sort of opaque coating applied to the top surface of the clear flexible substrate.” Ex-1025, 2:42-48 (Hicks). Hicks further teaches that “traces 70-76 of the present embodiment are formed on the top surface of the clear substrate 80 using a conductive ink (e.g., epoxy with silver).” Ex-1025, 10:15-17 (Hicks). Moreover, Hicks teaches that “[d]uring the ink deposition process, the remainder of the surface of the clear substrate 80 not covered by the conductive traces 70-76 (and not to be covered by the LED 40, 42 or Photodetector 38) may also be covered by an opaque nonconductive ink.” Ex-1025, 10:20-27 (Hicks). “That is, the non-patient side of the clear substrate 80 may be ‘painted’ to provide a light blocking shield for the sensor 30.” Ex-1025, 10:20-27 (Hicks); *see also* Ex-1025, 9:6-15 (Hicks) (“The

release liner 84, the interconnecting layer 82, the foam layer 86 and the clear substrate layer 80 are formed of materials that are substantially transparent to ultraviolet (UV) light. This allows UV light to pass through these layers 80-86 such that any adhesives used to attach the LEDs 40, 42 and photodetector 38 to the electrical traces 70-76 and/or to the clear substrate 80 (i.e., adhesive drop 110) may be cured with light (i.e., UV or visible depending on the adhesives) applied through the bottom of the flexible substrate 50 at or near the end of the manufacturing process.”), 12:2-13 (“[T]his embodiment further uses a cover layer 94 covering the top surface of the clear substrate. ... The cover layer 94 covers substantially the entire top surface of the clear substrate 80, excluding the portion of the clear substrate that makes up the integral connector 94. This cover film layer 94 is generally an opaque flexile layer made up of a material similar to the clear substrate 80 and is utilized for its light blocking characteristics.”).

106. U.S. Patent No. 8,954,135 to Yuen (Ex-1006) is another example of a moldable filler material or “potting material” used to seal the electronic components inside a wearable device. For example, Yuen describes that its biometric monitoring device “may be filled with gel that allows the sensor to experience pressure changes outside of the gel. The use of a gel filled altimeter may give the device a higher level of environmental protection with or without the use of an environmentally sealed vent. The device may have a higher survivability rate with a gel filled altimeter in

locations including but not limited to those that have high humidity, a clothes washer, a dish washer, a clothes dryer, a steam room, the shower, a pool, and any location where the device may be exposed to moisture, exposed to liquid or submerged in liquid.” Ex-1006, 20:65-21:8.

107. Yuen further emphasizes the importance of having a watertight seal of the device. *See, e.g.*, Ex-1006, 15:1-4 (“structural integrity of the device while accommodating watertight seal for the sensor package”), 20:52-64 (“prevents and/or minimizes water and other liquids penetration into the device housing”). Yuen describes that its “package or module of the optical sensor would be connected to the device with a pressure sensitive adhesive and a liquid gasket. (See, FIG. 7). Screws, rivets or the like may also be used, for example, if a stronger or more durable connection is required between the optical sensor package/module and the device body. Notably, the present inventions may also use watertight glues, hydrophobic membranes such as Gore-Tex, O-rings, sealant, grease, or epoxy to secure or attach the optical sensor package/module and the device body.” Ex-1006, 15:5-14.

108. Numerous other examples of the types of coatings that may be used to cover electronics in an electronic device are taught in the art. *See, e.g.*, Ex-1034, 4:54-5:2 (Asada ’199) (“Lightweight cover 25 is preferably made of cast acrylic. The inner diameter widens to couple to base unit. The main function of the cover is to protect the sensors from outside elements. ... Base unit 23 is preferably made of

the same cast acrylic material as cover 25 and is toleranced to provide a secure fit by means of friction. ... Moreover, this component aids in shielding the ambient light, which the cover unit could not handle.”); Ex-1026, 4:47-55 (Hannula) (“In one embodiment of the present invention, the inner side 125 of layer 112 is covered with a laminated opaque film. The opaque film blocks ambient light that may interfere with photodetector 116. The opaque film may comprise polyethylene. The opaque film may be black or some other dark color that helps block ambient light and reduces shunted light. Dark in color is understood here to be of a nature with little reflectance of the wavelengths of light sensed by the sensor’s photodetector.”); Ex-1028, 1:46-50 (Kimura) (“A surface treatment (such as painting black) for preventing the reflection of light has been carried out on the inside of this attachable device 1. The sensor 2 has a light-emitting diode 22 and a photo diode 23 mounted in a package 21 molded inside the attachable device 1.”); Ex-1029, 0013 (Tremper) (“Clinically, ambient light artifact can be minimized by covering the sensor with an opaque shield.”); Ex-1057, 1807 (Ross) (Liquid Crystal Polymer (LCP) was known to be a “class of high performance, high temperature thermoplastic polymers which can be formulated to provide injection molding compounds having properties uniquely advantageous for electronic cavity packages. ... [T]his polymer class, together with ancillary materials such as metal leadframes and adhesives, ... combine to produce a range of cavity package configurations that can compete in

the same performance arena as ceramics.” Ex-1057, 1807 (Ross); Ex-1055, 78 (Ardebili) (“Coloring agents are added to the molding compound to distinguish between different device types in packages and eliminate device visibility through the normally pale yellow epoxy encapsulant. The colors are produced by the addition of thermally stable organic dyes or pigments.”).

3. Windows and transparent materials were commonly used for emission and detection

a. Windows for optical transmission, such as light emission and detection

109. As discussed further below, optical sensors are used to obtain continuous measurements of a patient/user’s biometric data. For example, U.S. Patent No. 4,880,304 to Jaeb et al. (“Jaeb”) explains how “it is extremely important to be able to obtain continuous measurements of a patient's tissue oxygenation” Ex-1042, 1:15-17. Jaeb notes that although an actual blood sample is considered the most accurate method, it is “undesirable in cases where it is necessary to monitor blood oxygen saturation over long periods of time.” *Id.*, 1:20-34. Therefore, Jaeb disclosed how a noninvasive oximeter “capable of detecting significant changes in the blood oxygen content would be especially useful.” *Id.*, 1:31-34. Jaeb taught a “optical sensor which has increased sensitivity and which is resistant to the effects of ambient light” by having the sensor housing having “central protrusion in which a plurality of light emitting diodes and an optical sensor are mounted in a vertical

configuration.” *Id.*, 2:49-53. This allows the sensor to be placed on the patient’s tissue so that the “sensor face containing the LEDs and detector protrudes slightly into the tissue” “thereby increasing the signal strength of the detected signal.” *Id.*, 3:54-65, 5:13-17. Therefore, the sensor face is directly exposed to the user’s skin.

110. Jaeb explains that the placement of the LEDs and sensor is important to prevent problems related to signal strength and susceptibility to interference. *See, e.g.*, Ex-1042, 4:59-62. For example, as shown in Figure 2B, when the “lower face of the housing 12 contains LEDs 16 and 18 which emit light in the red and infrared spectra [*sic*], respectively, and an optical sensor 20 for detecting light reflected by subsurface tissue” causes issues of interference by “by ambient light entering from the perimeter of the sensor housing.” *Id.*, 4:51-58, 5:1-3.

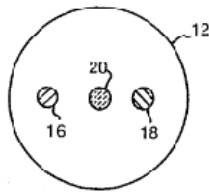


FIG. 2a

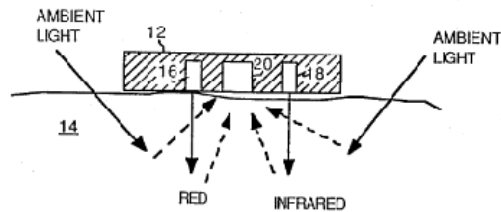


FIG. 2b

111. Jaeb explains and shows in Figures 3a and 3B that a light absorbing pad 30 can be attached to the lower face of the sensor to reduce “Interference due to ambient light entering from the edges of the sensor.” Ex-1042, 5:17-21. However,

Jaeb further explains that “[i]nterference due to ambient light is further reduced by recessing the LEDs 16, 18 and the detector 20 within the housing and by coating the respective LEDs with a polymer sealant 32. The coating provides improved optical index matching and also provides an electrical and biological seal between the sensor and the tissue.” *Id.*, 5:21-27.

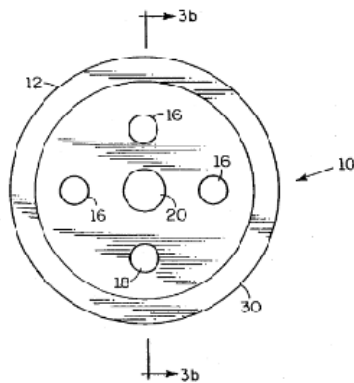


FIG. 3a

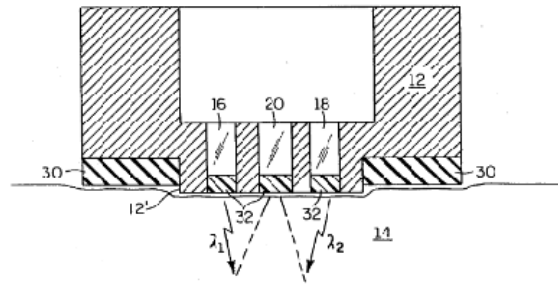


FIG. 3b

112. U.S. Patent No. 8,954,135 to Yuen (Ex-1006) is another example of using transparent material over LED sensors. Yuen acquires the user's biometric data by light from optical sensors, or LEDs, emitted through a “window” made of “plastic or a glass layer.” Ex-1006, 10:55-66. Specifically, Yuen describes a window “in the housing to facilitate optical transmission between the optical sensors and the user.” *Id.* The window permits the light to be emitted by one “or more LEDs, onto the skin of the user and a response or reflection to pass into the housing to be sampled, measured and/or detected by, for example, one or more photodiodes.”

Id.; see also *id.*, Claim 6 (“the window includes a first portion having first optical properties and a second portion having second optical properties different from the first optical properties.”).

113. Yuen discusses three light sources separate from one another emitting different wavelengths of light: “an LED that emits light having wavelengths corresponding to the green spectrum,” “an LED that emits light having wavelengths corresponding to the red spectrum,” and “an LED that emits light having wavelengths corresponding to the IR spectrum.” Ex-1006, 10:29-31, 10:34-39. Yuen’s biometric monitoring device has optical sensors “arranged on the skin side” so light is emitted upon the user’s skin and detected by a light detector to measure a “user’s heart rate, respiration, heart rate variability, oxygen saturation (SpO₂), blood volume, blood glucose, skin moisture and/or skin pigmentation level.” Ex-1006, 10:7-21. In this situation there are thus multiple windows for each LED. Yuen claims “the window includes a first portion having first optical properties and a second portion having second optical properties different from the first optical properties” where the “the first portion of the window and the third portion of the window are spaced apart and separated by the second portion of the window.” *Id.*, claims 6, 11.

114. Yuen explains that its optical window can be in the form of a protrusion also:

The light emitter(s) and/or detector(s) of the optical sensor may be disposed or arranged in the protrusion juxtaposed the window or light transmissive structure. As such, when attached to the user's body, *the window portion of the protrusion* of the biometric monitoring device engages the user's skin with more force than the surrounding device body—thereby providing a more secure physical connection between the user's skin and the optical window. That is, a protrusion improves sustained and/or fixed contact between the biometric monitoring device and the user's skin (for example, the skin of a predetermined portion of the user's body) which may reduce the amount of stray light measured by the photodetector, decrease motion between the biometric monitoring device and the user, and/or provide improved local pressure to the user's skin; all of which may increase the quality of the cardiac signal of interest.

Ex-1006, 13:39-62.

115. Yuen explains that the windows can also be used on the exterior of the housing. As shown in Figure 12 below, an “optical heart rate monitor ... disposed or located on one or more external or environmental side surfaces of the biometric monitoring device.” Ex-1006, 12:62-65. “The user may touch an optical window (behind which optical elements of the optical heart rate monitor are located) with a finger on the opposing hand to initiate a heart rate measurement (and/or other metrics related to heart rate such as heart rate variability) and/or collect data which may be used to determine the user's heart rate (and/or other metrics related to heart rate).”

Ex-1006, 12:65-13:5.

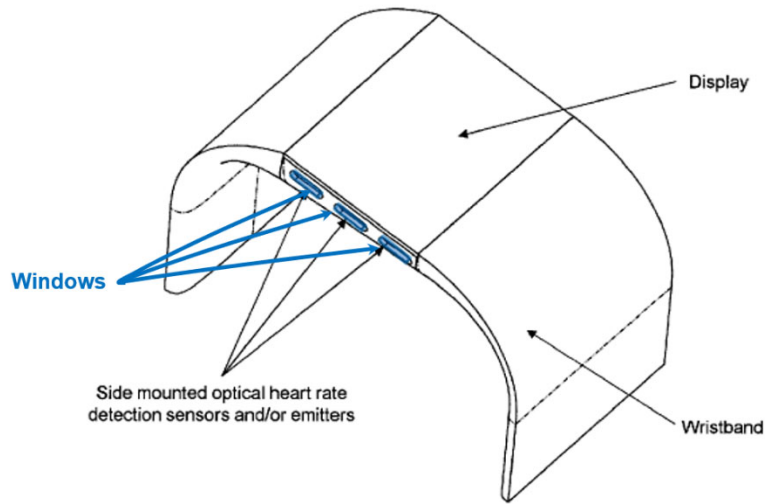


FIG. 12

116. Yuen explains that the light transmissive structure has an “optically opaque portion (including certain optical properties) and an optically transparent portion (including optical properties different from the optically opaque portion.” Ex-1006, 11:49-33. Such a structure is provided by a “double-shot or two step molding process wherein optically opaque material is injected and optically transparent material is injected” to form a “light transmissive structure having an optically opaque portion (including certain optical properties) and an optically transparent portion (including optical properties different from the optically opaque portion).” Ex-1006, 11:33-36. This allows the windows to have “different transmissive properties for different wavelengths depending on the direction of light travel through the structure. For example, in one embodiment, the optically opaque material may include a property of being reflective to a specific wavelength range

so as to more efficiently transport light from the light emitter(s) and from the user's body back to and detected by the detector (which may be of a different wavelength(s) relative to the wavelength(s) of the emitted light)." Ex-1006, 11:36-46; *see also id.*, Claims 7-8 (the windows can be "optically opaque" to certain wavelengths, such as light in the visible spectrum).

117. U.S. Patent Publication No. 20130211291 to Tran ("Tran," Ex-1045) also discusses an "optical heartbeat detector" with an "optical transducer is positioned on a finger, wrist, or ear lobe." Ex-1045 ¶295. In the finger pulse oximeter, Tran's device "emits lights from a window in the infrared spectrum and receives reflected light in a second window. When the heart beats, blood flow increases temporarily and more red blood cells flow through the windows, which increases the light reflected back to the detector. The light can be reflected, refracted, scattered, and absorbed by one or more detectors. Suitable noise reduction is done, and the resulting optical waveform is captured by the CPU." Ex-1045 ¶295.

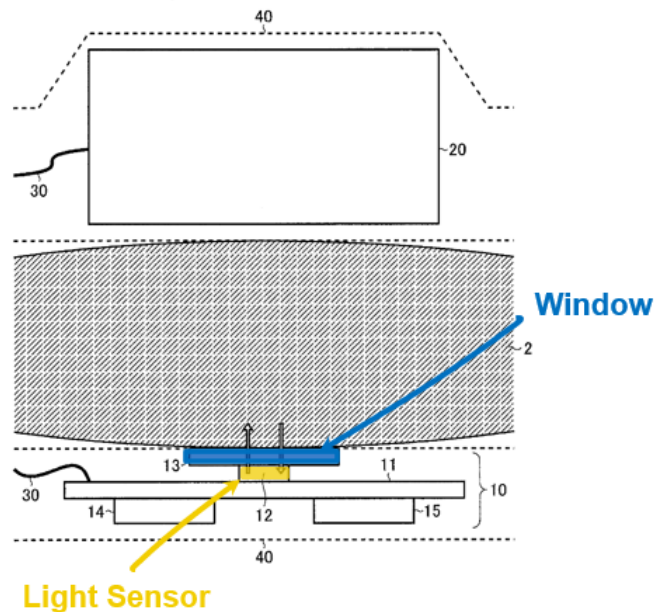
118. U.S. Patent Publication No. 20120016245 to Niwa ("Niwa," Ex-1005) is another example of using a transparent window. Niwa teaches a wearable electronic sensing device with light-emitting and light-receiving components to acquire a plethysmogram—e.g., information relating to blood volume—of the wearer. *See* Ex-1005. Niwa teaches a ring-shaped device that surrounds "the ball

side of the finger 2 (i.e., palm side) when the finger ring type housing 40 is worn” for the plethysmogram measurement. Ex-1005 ¶192.

119. As shown in Figure 27, Niwa shows a “measurement window 13.” Specifically, Niwa’s finger ring has a first unit 10 which is a “unit to measure the plethysmogram mainly, which is contained within the finger ring type housing 40 to be set to the ball side of the finger 2 (i.e., palm side) when the finger ring type housing 40 is worn on the third joint of the third joint of the finger 2.” *Id.* The first unit 10 is supplied with power from the second unit 20. Ex-1005 ¶193. The first unit 10 includes “substrate 11, a light sensor 12, an amplifier circuit 14, and a processing circuit 15” and a “translucency portion which forms the measurement window 13.” Ex-1005 ¶200. The measurement window is provided at the light emitting/receiving surface of the light sensor.” Ex-1005 ¶30. Niwa discusses that the measurement window 13 is made “with the translucency portion (i.e., a glass plate or an acrylic plate) which is provided at the light emitting/receiving surface of the light sensor 12” in order for the light sensor 12 “to perform measurement of the plethysmogram (i.e., detection for the emitted light to the finger 2 and a reflected light go back from the finger 2) via this measurement window 13.” Ex-1005 ¶210. The thickness of the measurement window 13 depends on the design “in view of the depth of focus of the light sensor 12.” *Id.* As shown below in Figure 27, the measurement window (blue) allows for the light to be emitted from the light emitting

portion (yellow) to the user's finger when pressed to the measurement window. Ex-
1005 ¶117.

FIG.27



120. Similarly, WO2001017421A1 (“Lindberg”) (filed Sept. 7, 2000), explains using “transparent silicone” over the light sources and detectors. Lindberg relates to a non-invasive method for determination of SpO₂ by:

- a) directing light beams against the mixture;
- b) determining at least one blood characteristic other than SpO₂ including hemoglobin of the mixture by analyzing the intensity of the light reflected from the mixture, or the intensity of the light reflected from the mixture in combination with the intensity of the light transmitted through the mixture; and
- c) determining oxygen saturation, SpO₂, of the mixture by analyzing the intensity of the light transmitted through the mixture.

Ex-1046, 0005 (page numbered 4).

121. Lindberg directs light beams using “light sources” comprising of a first light source for emitting a first light beam with a wavelength in the red light range and a second light source for emitting a second light beam in the infrared light range. Ex-1046, 0007 (page numbered 6); *see also id.*, 0010 (page 9) (explaining that the light sources may be light emitting diodes). The apparatus comprises a first detector for detecting the intensity of the light of the red light beam and a second detector for detecting the light form the infrared light beam. Ex-1046, 0007 (page numbered 6). Lindberg explains that when using the light sources and detectors “for reflection” they are incorporated and covered with transparent silicone. *Id.*, 0020 (page numbered 9). Therefore Lindberg describes using a transparent material such as silicone over the LEDs.

122. WO 2011/132009 to Nyiradi (Ex-1047) is another example of having an LED under a translucent material. Specifically, Nyiradi teaches a “driving indicator with LED integrated in bracelet for cyclists and motorcyclists.” Ex-1047, 0002. The bracelet can have a “plastic arm strap 11” made of a “transparent, translucent version of the special plastic” so that it “becomes possible for the light of the LED 4 placed into [t]he plastic arm strap 11 itself to penetrate the material of the plastic arm strap 11.” Ex-1047, 0012 (numbered page 11).

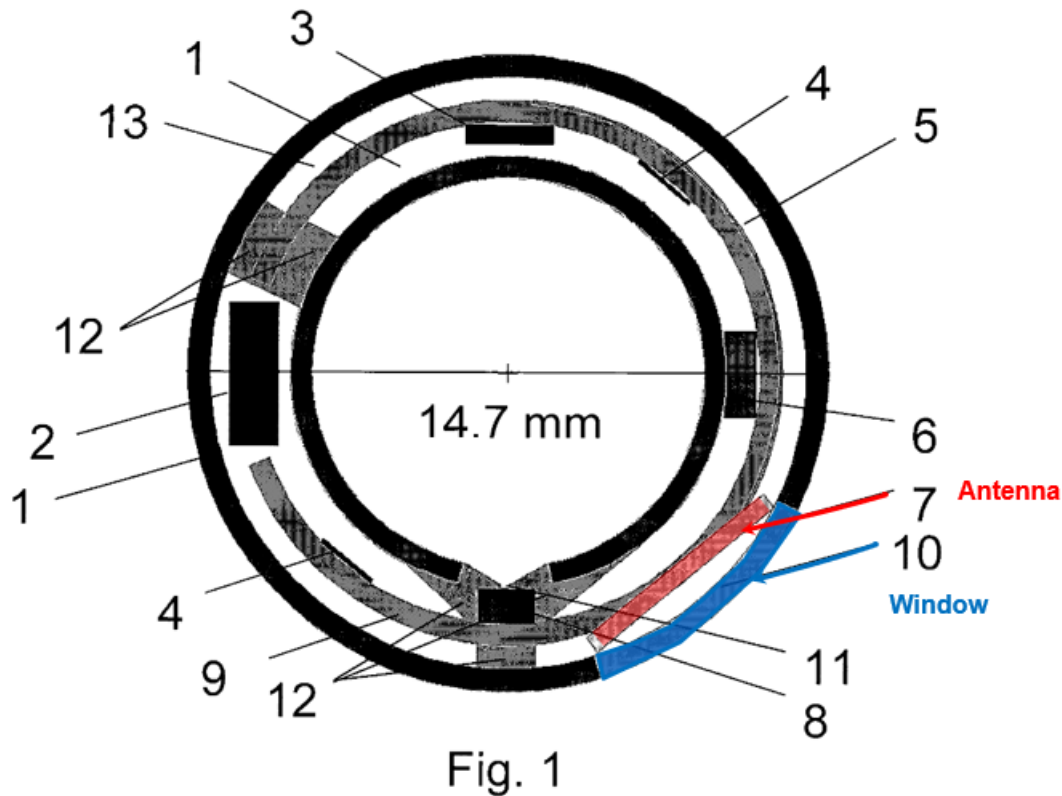
123. Therefore, windows and transparent materials for optical transmission were well-known in order to focus the light from a light-emitting component, such as a light emitting diode, to be emitted through and reflected back to the light receiving component, such as a photodetector.

b. Windows for RF transmission and detection

124. Windows were also commonly used for radio frequency transmission. For example, U.S. Patent Application Publication No. 2012/0218184 to Wissmar (Ex-1013), teaches an electronic finger ring with electronic components packaged and integrated within the ring for radio frequency (RF) transmission. Ex-1013, Abstract. Wissmar's finger ring is a toroidal shaped finger ring structure, "constituted of two different metallic shells: (i). 1 a, made of gold (Au) or silver (Ag), enclosing the major parts of the finger ring structure geometrically described as radially furthest away from the toroids centre, and (ii). 1 b, made of a titanium compound (Ti, TiW), being the metal enclosing facing the inner parts of the finger ring structure." Ex-1013 ¶73.

125. As shown below in Figure 1, the "toroidal shaped finger ring structure 1 is comprised of different electronic components: a battery 2, a RF transceiver 3 and a micro processor 4, a microstrip line 5, an accelerometer 6, an internal antenna 7, a pressure sensor 8; all mounted on a flexible printed circuit board 9. In this embodiment, there is also an outer metal shell opening 10 serving as an RF window

letting through unperturbed RF radiation.” Ex-1013 ¶73. All electronic components, including “an antenna,” are mounted on a flexible printed circuit board (FPCB). Ex-1013 ¶¶71, 91. The antenna is specifically “located under the portion of the ring which has no outer shell metal” to allow “unperturbed RF radiation” when the outer shell is made of a metal that would otherwise prevent RF radiation from passing. Ex-1013 ¶91.



126. Similarly, U.S. Patent Application Publication No. 2014/0361945A1 to Misra et al. (“Misra,” Ex-1048) explicitly teaches a radio-frequency transparent window from 2013. Specifically, Misra explains that antenna architecture is an “integral part of portable electronic devices” and how housings and structural

components are often made from conductive metals, which can serve as a ground for an antenna. Ex-1048 ¶2. However, “nonconductive regions that are transparent to radio-frequency (RF) radiation ... provide a good radiation pattern and signal strength” such as conventional “antenna windows in portable electronic devices include a plastic antenna window or a plastic split in a housing forming a gap in the conductive metal.” *Id.* Misra explains that the break in cosmetic metal surface “breaks the consistent visual profile,” so that POSITAs desired “an RF transparent window that provides good signal quality to an antenna inside the housing of a portable electronic device while also providing structural support and visual consistency to the housing.” *Id.* ¶3. Misra provides a patch for a device in an electronic housing that has a thickness to provide a selected radio-frequency transmissivity and structural support. *See, e.g., id.* ¶¶4-8. Therefore, Misra provided an antenna window to provide radio frequency transmissivity.

127. Moreover, U.S. Patent Application Publication No. 2014/0361934 to Ely et al. (“Ely,” Ex-1049) describes an electronic device house with a “window aligned with the radio-frequency (RF) antenna. Ex-1049 ¶5. Ely describes how antenna windows in aluminum enclosures are challenging. *Id.* ¶31. Ely provides a solution by providing a window that “non-conductive material filling a gap in the aluminum layer and a thin aluminum oxide layer adjacent to the aluminum layer and to the non-conductive material. The non-conductive material and the thin aluminum

oxide layer form an RF-transparent path to allow transmission of substantially all RF radiation through the window.” *Id.* In order to make the window, Ely explains that the process includes “anodization of the exterior housing and then etching away on the interior of the housing antenna windows at desired locations for antenna windows, followed by filling in the etched portions with plastic, paint, or other suitable material to maintain structural integrity. The aluminum oxide can be substantially clear or transparent, allowing the filling material to show through. The resulting housing is cosmetically pleasing and without cracks or apparent plastic portions.” *Id.* ¶31. The window in the aluminum housing “allows transmission of substantially all RF radiation through the window portion.” *Id.* ¶7. Ely describes how the antenna windows may not only have the antenna but also have other sensors included in the electronic device. *Id.* ¶¶33, 40, 51.

128. In summary, windows in electronic device housings are particularly helpful for RF transmission.

D. Adjustment of Operational Parameters of Sensors and Other Electronic Components Was Known

129. Adjusting a sensor’s operational parameters or measurement periodicity based on information from a sensor or battery was well known prior to 2013.

130. For example, European Patent No. 2281205 to Chen (“Chen,” Ex-1050) discusses “general principles that can reduce the power consumption” of a sensor system, including using passive sensors to detect activity to then turn on other sensors and varying the sampling rate of sensors “depending on the current state”—e.g., “when little or no motion is occurring.” Ex-1050 ¶33. Chen describes a system that “selectively provide[s] power to one or more other sensors and/or process in response to” a sensor detecting “motion of a user.” *Id.* ¶14. Chen further explains that “power consumption of the system is significantly reduced (and hence the battery lifetime is increased) during periods when there is no or little motion.” *Id.* ¶15; *see also id.* ¶20 (“Preferably, the system is configured to stop power being supplied to one or more of the other sensors and processor in the event that the passive vibration sensor detects that the motion has ceased.”). Chen also describes “increas[ing] a sampling rate of the one or more sensors in response to the passive vibration sensor detecting motion.” *Id.* ¶22; *see id.* ¶33 (“[T]he sampling rate of the sensors can be varied depending on the current state in order to minimize the power consumption when little or no motion is occurring.”). Thus, adjusting a sensor’s measurement periodicity was also routine in monitoring applications.

131. For example, as explained in 2009 by Lawrence Au, “[e]nergy efficiency presents a critical design challenge in wireless, wearable sensor technology.” Ex-1051, Abstract. Au explains that to maximize monitoring system’s

lifetime and maintain accuracy, “wearable sensors require hardware support that allows dynamic power control on the sensors ... as well as monitoring algorithms to control these components intelligently.” *Id.* Au suggested using “episodic sampling, ... a context-aware scheduling technique where context classification occurs only episodically,” rather than the “traditional continuous sampling.” *Id.*, 2. For example, the experiment performed in Au compared episodic sampling against continuous sampling for both low-dynamic activity (“rest”) and high-dynamic activity (“running”). *Id.*, 4. The experiment classified the activity based on measurements from a heart rate sensor, respiratory sensor, and wearable accelerometer. *Id.*, 4, Fig. 1. In some instances, episodic sampling extended battery life. *Id.*, 4, Fig. 5.

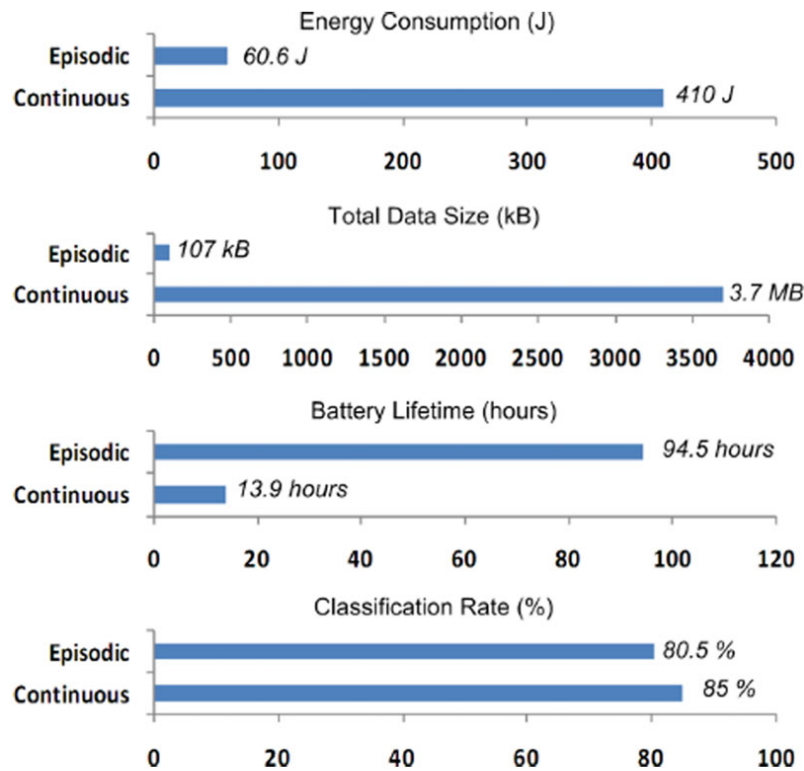


Fig. 5.
Experimental Results - Continuous vs. Episodic Sampling

Thus, adjusting measurement periodicity was known in wireless healthcare applications.

132. Therefore, it was well known that adjusting a sensor's operational parameters or measurement periodicity based on a user's activity or sensor information could reduce power consumption of a device.

133. Also well-known by 2013 was the need to minimize power consumption of other electronic components, in particular components with high power requirements such as transceivers. As a publication by Chen noted in 2009, in a wearable sensor system "[m]ost power is consumed by the wireless transceiver." Ex-1067, 3 (Chen 2). As shown in Table 1 from Chen, reproduced below,

transceivers typically have orders of magnitude higher power requirements than, for examples, microcontrollers or accelerometer.

Table 1- Power, size, and weight analysis for the wearable sensor unit

Component	Typical current (mA)	Size (mm)	Weight (oz)
MMA7260Q accelerometer	0.5	6×6×1.45	0.05
C8051F353 microcontroller	5.8	9×9×1.6	0.05
XBee 802.15.4 transmitter	45	25×28×2.8	0.14
Li-Ion 18650 battery pack	-	69×54×18	9.0

134. Therefore, A POSITA knew at the time that minimizing power consumption in transceivers was crucial for enhancing battery life, reducing heat generation, and improving overall system efficiency, especially in wearable electronic devices. Wearables, such as fitness trackers, smartwatches, smart rings, and health monitoring devices, rely heavily on efficient power management to ensure long battery life while maintaining functionality. One fundamental approach to efficient power management is efficient circuit design, which includes selecting low-power components and integrating sleep or standby modes. Sleep modes are particularly effective because they allow the transceiver to enter a low-power state during periods of inactivity, significantly reducing power usage when the device doesn't need to transmit or receive data.

135. Dynamic Voltage and Frequency Scaling (DVFS) also plays a pivotal role by adjusting the voltage and frequency according to transceiver workload, a rest mode between fully awake and sleep, ensuring efficient operation even when the device is active. Power management techniques like power gating and clock gating are essential, as they turn off power or disable the transceiver clock signal to idle parts of the circuit, maximizing power savings when combined with sleep modes. Energy-efficient modulation schemes, such as binary phase-shift keying (BPSK) or quadrature amplitude modulation (QAM), further reduce power consumption, especially when paired with sleep modes to conserve energy whenever possible.

136. Efficient antenna design and beamforming techniques maximize signal transmission and reception efficiency, reducing power needs and allowing the transceiver to remain active only when necessary. Power-efficient protocols and data reduction techniques minimize the amount of data transmitted or received, further optimizing power consumption. Hardware and software co-design, which involves co-optimizing algorithms and components, results in lower power consumption. Intelligent software management of transitions between active and sleep states enhances the effectiveness of these strategies.

137. A combination of these strategies, particularly the effective use of sleep modes, can significantly reduce power consumption for transceivers in wearable electronic devices. This leads to longer battery life and improved user experience,

tailored to the specific requirements and constraints of the application, such as performance, cost, and form factor.

138. As an example, Mestas teaches that its athletic monitoring wristband had a sleep mode and can “exit[] the sleep mode...upon an activity sensor detecting movement or activity.” Ex-1010 ¶231. U.S. Patent No. 9,218,058 to Bress et al. (“Bress”) teaches a finger-ring based gesture recognition device with a low-power or “sleep” mode, further explaining that “[e]nergy management is critical in wireless devices.” Ex-1016, 15:61-64. Bress further teaches that in the “sleep” mode, “many of the subsystems may be shut down,” including “[a]ny and all of the communications channels, such a Blue Tooth...and WiFi.” *Id.*, 16:3-7 (Bress). The processor polls the sensors, including motion sensors and “[s]ensor data during the brief awake times would determine if there is any need to stay awake to verify a change of state, resume sleep, or fully wake up.” *Id.*, 16:8-14 (Bress). U.S. Patent Publication No. 2011/0080339 to Sun et al. (“Sun”) teaches a finger mouse with a “a suspension mode, sometimes referred to as ‘go to sleep,’” which could be activated by a particular gesture. Ex-1015 ¶37 (Sun); *see also id.* ¶42 (disclosing a predefined gesture, “Single tap on top side 80,” as corresponding to the “Go to sleep” command).

E. Gesture Recognition Sensors and Techniques Were Known

139. Gesture recognition technology provides an interface between humans and machines, enabling intuitive and natural interaction without the need for traditional input devices such as keyboards or mice. This technology, which was well known to a POSITA by 2013, leverages sensors embedded in wearable or handheld devices, or non-contact ambient sensors, to interpret human gestures, facilitating applications across various domains such as gaming, healthcare, and automation.

1. Hardware for gesture recognition was well-known

140. Gesture recognition technology is embedded in various devices designed for both everyday use and specialized applications. Such devices were in existence and well known to a POSITA by 2013. These devices leverage the combined capabilities of accelerometers, gyroscopes, magnetometers, cameras, and retroreflectors to provide accurate and responsive gesture-based interactions. Software algorithms, also well-known by 2013, process and interpret gesture data, determining whether it matches pre-defined gesture patterns.

141. Accelerometers: Accelerometers are sensors that measure acceleration forces along three axes (x, y, and z). These forces can arise from gravity or movement, providing important data about the device's orientation and motion. In gesture recognition, accelerometers are used to detect linear movements and tilts.

Their small size, low power consumption, and affordability make them ideal for integration into wearable devices such as smart rings and watches, as well as handheld controllers.

142. From a technical perspective, accelerometers function based on the principle of piezoelectricity or changes in capacitance, which are converted into electrical signals proportional to the acceleration. They capture detailed information about the speed and direction of movements, enabling differentiation between various types of gestures. For example, a rapid flick of the wrist can be distinguished from a gentle wave based on the acceleration profile captured by the sensor. This capability is essential for applications requiring precise gesture recognition, such as in fitness tracking and gaming.

143. Accelerometers and their use in wearable electronic devices were well-known by 2013. For example, U.S. Patent Publication No. 20140244009 to Mestas teaches a wearable athletic monitoring device having various sensors, including an accelerometer for detecting the user's motion. Ex-1010 ¶201 (Mestas). U.S. Patent Publication No. 2010/0219989 to Asami et al. ("Asami") teaches a finger ring including a current sensor and a triaxial acceleration sensor for recognizing characters and figures drawn by the user. Ex-1014, Abstract. U.S. Patent Publication No. 2011/0080339 to Sun et al. ("Sun") teaches a wrist/finger mouse that detects the motion of the user's wrist or finger using an acceleration sensor. Ex-

1015 ¶¶24, 36 (Sun). U.S. Patent No. 8,031,172 to Kruse et al. (“Kruse”) teaches a haptic ring that identifies gestured performed by the user wearing it based on motion sensed by an accelerometer. Ex-1017, 3:34-39 (Kruse). U.S. Patent No. 9,218,058 to Bress et al. (“Bress”) describes a wearable input device, referred to a “Imagine,” with motion sensors, including accelerometers, in rings worn by the user on their finger. Ex-1016, Abstract, 6:13-16, Fig. 4 (Bress). A 2010 study described that “the technology of sensors is advancing significantly, allowing for very small, body-worn, wearable sensors...suitable for intuitive wearable computing systems. Traditionally used sensors, which are small and come at very reasonable costs are accelerometers, gyroscopes and magnetometers.” Ex-1068, 1 (“Amma”). Amma notes that the accelerometers used in their wearable input device are “3-axis accelerometers [] available as standard flat integrated c[i]rcuits.” *Id.*, 2 (Amma). Another publication describes a “ring shape,” “micro wearable device based on a tri-axis accelerometer” that is “put [] on a finger to detect the finger gestures.” Ex-1069, Abstract, Fig. 1 (“Zhou”). The Zhou device used an off-the-shelf tri-axis accelerometer, MMM7361L from Freescale Semiconductor, Inc. *Id.*, 2.

144. Gyroscopes: Gyroscopes measure the rate of rotation around three perpendicular axes, offering detailed information about the device’s angular velocity. When used in conjunction with accelerometers, gyroscopes enhance the accuracy of motion tracking by providing complementary rotational data. This

synergy is particularly beneficial in dynamic environments where precise gesture recognition is required, such as in gaming controllers and virtual reality systems.

145. Gyroscopes function based on the Coriolis effect in MEMS (Micro-Electro-Mechanical Systems) devices, where vibrating structures are used to detect changes in orientation. Gyroscopes enable the system to track the orientation. The ability to measure rotational velocity also aids in distinguishing between different types of gestures, such as a twist versus a spin, by analyzing the rate and axis of rotation.

146. Gyroscopes and their use in wearable electronic devices were well-known by 2013, and gyroscopes were often used in conjunction with accelerometers for additional versatility in detecting various motions, in particular for gesture recognition. For example, Mestas teaches that in its athletic monitoring device “[p]hysical gestures and movements may be detected using an accelerometer, a gyroscope and/or other sensors.” Ex-1010 ¶221 (Mestas). Sun teaches that “representative MEMS [microelectromechanical systems]” sensors for its gesture-based wrist/finger mouse include, besides accelerometers, “gyroscopes, including capacitive or piezoelectric vibrating gyroscopes.” Ex-1015 ¶25 (Sun). Bress’s gesture-recognition input device similarly teaches that its finger-ring motion sensors include gyroscopes. Ex-1016, Fig. 4 (Bress). The publication by Amma in 2010 also teaches the use of “gyroscopes for measuring angular velocity” in wearable

input devices. Ex-1068, 2 (Amm). Similarly, Park noted in 2011 that “[r]ecently, hand-worn accelerometer and gyroscope sensor-based gesture recognition has been successfully used in mobile and pervasive computing. This approach is appealing because it is low cost, low power, requires only lightweight processing, and can be implemented with compact form factors. Several projects have proposed gesture recognition systems based on a wide range of sensing form factors.” Ex-1070, 262 (Park). Park further explains that “while the accelerometer is often used in gesture recognition systems...recent research demonstrates that additional use of a gyroscope can improve gesture classification accuracy...by up to 4% because it can detect rotational movements.” *Id.*, 263.

147. Magnetometers: Magnetometers detect magnetic fields, allowing devices to determine their orientation relative to the Earth’s magnetic field. This capability is useful for maintaining accurate spatial orientation over time, especially when combined with accelerometer and gyroscope data in sensor fusion algorithms. Magnetometers are commonly found in devices and controllers, where they contribute to reliable and accurate gesture-based interactions.

148. From a practical standpoint, magnetometers function using the Hall effect or magnetoresistive effects, converting magnetic field strength into an electrical signal. They play an important role in correcting drift errors in gyroscopes by providing an absolute reference point based on the Earth’s magnetic field. This

is particularly important in applications such as navigation and applications, where precise spatial awareness is critical. The use of magnetometers for motion sensing and gesture recognition was well-known by 2013. For example, Amma described that by 2010 “the technology of sensors is advancing significantly, allowing for very small, body-worn, wearable sensors...suitable for intuitive wearable computing systems. Traditionally used sensors, which are small and come at very reasonable costs are accelerometers, gyroscopes and magnetometers.” Ex-1068 at 1 (Amma).

149. Other hardware for gesture recognition: There were other devices for gesture recognition known to a POSITA by 2013, including cameras and retroreflectors. Cameras in gesture recognition systems offer high-resolution visual data that can be processed to interpret complex gestures. By capturing images or video frames of the user’s movements, cameras enable a non-invasive method of gesture tracking that does not require physical contact with the device. Retroreflectors are materials that reflect light back to its source with minimal scattering, enabling precise tracking of objects equipped with these reflectors. When combined with cameras or infrared sensors, retroreflectors can enhance the accuracy of gesture recognition systems by providing distinct and easily detectable markers on the user’s body or accessories. In practical terms, retroreflective markers can be placed on gloves, rings, or wristbands, allowing cameras or infrared sensors to track the precise position and movement of the hands and fingers. Examples of such

devices are described, for example, by Rekimoto, who describes several gesture recognition systems, including a “camera-based gesture recognition system that can be worn like a pendant.” Ex-1071, 22 (Rekimoto).

2. Gesture recognition techniques were well-known

150. The interpretation of sensor data into recognizable gestures relies on algorithms that process and analyze the raw data collected by hardware sensors. Virtually all gesture recognition performed by an electronic device employs such algorithms. These algorithms transform motion and orientation data into meaningful gestures that are compared for recognition against a predetermined patterns and acted upon by the system based on the outcome of that comparison. Such algorithms were well-known by 2013. For example, Park noted in 2011 that “[m]any gesture classification algorithms have been proposed to classify a segmented gesture into one of many predefined gestures or as garbage, e.g., HMM, Template matching...Dynamic Time Wrapping (DTW)...and light-weight HMM.” Ex-1070, 262 (Park).

151. Template Matching: This approach compares input gestures, defined as time series signals, to pre-defined templates stored in the system by calculating the correlation between the two and is among the simplest gesture recognition algorithms. This technique is particularly effective for detecting specific gestures from sequences of sensor data, such as those captured by accelerometers,

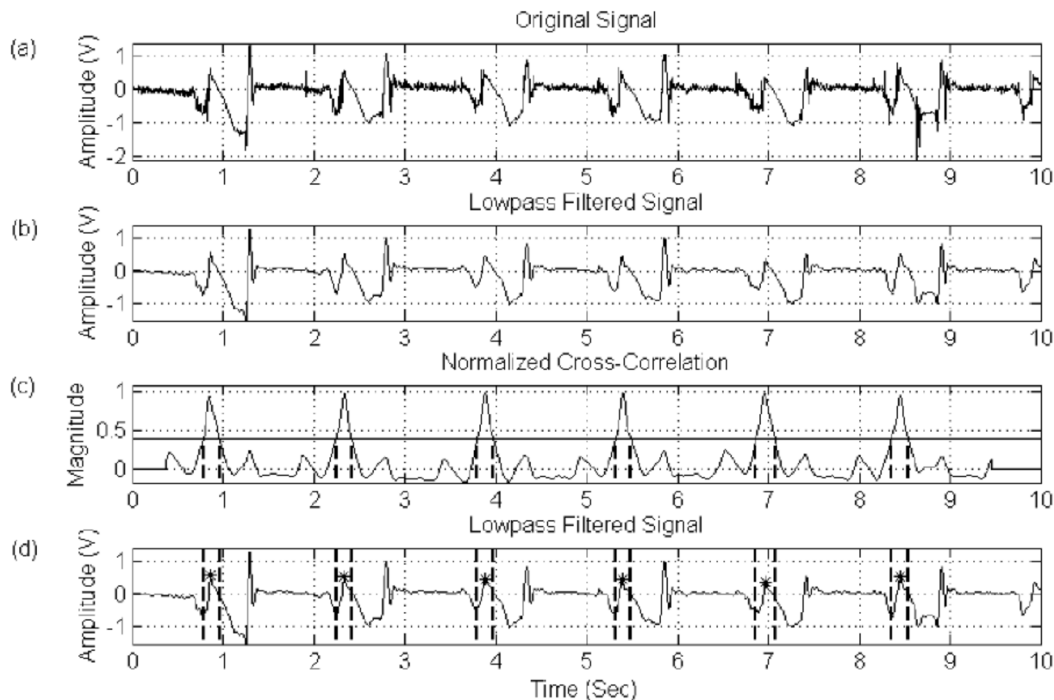
gyroscopes, and other sensors. The primary objective is to detect/locate the point in the time series where the gesture template best matches the observed signal. When a user performs a gesture, the template matching algorithm calculates the similarity between the input data and the templates to determine the best match, usually by calculating coefficients of correlation between the detected motion and the stored template.

152. Cross-correlation is a method that measures the similarity between two time series as a function of the time-lag applied to one of them. The core of cross-correlation involves computing the cross-correlation function for each possible time lag. Normalized cross-correlation, on the other hand, extends the principles of cross-correlation by accounting for differences in signal amplitude and energy, thus providing a more robust measure of similarity. This normalization is used for comparing signals of significantly varying magnitudes.

153. Template matching using cross-correlation and normalized cross-correlation is straightforward and efficient, making it suitable for applications with a limited set of predefined gestures. The simplicity of these methods makes them easy to implement and interpret. Normalized cross-correlation, in particular, provides robustness to variations in signal amplitude and energy, making it effective in real-world applications. These methods can be efficiently computed, even for large datasets, using fast Fourier transform (FFT) techniques. However, their

simplicity can also be a limitation in scenarios requiring recognition of a wide variety of gestures.

154. As an example of template matching using cross-correlation, Ying described an automatic step detection using an accelerometer signal. Ex-1072 (Ying). Ying describes that “[t]he main concept of the template-matching method is to generate a template, which represents a typical step cycle. In the unknown signal, an event is declared to be detected when there is a match between the signal and the template to certain degree.” *Id.*, 82 (Ying). Ying describes that “the normalized cross-correlation...is calculated between the template and signal,” and the peak values in the calculated normalized cross-correlation, shown in Figure 6 of Ying, reproduced below, represent the pattern detected in the signal.



155. As an example of template matching for gesture recognition, Sun describes the use of “comparator logic” for use in “comparing input sequences of data indicating gestures ... with stored sequences of data specifying the unique signatures for memorized gestures.” Ex-1015 ¶43 (Sun).

156. Statistical Methods - Hidden Markov Models (HMMs): HMMs represent gestures as sequences of observable events, capturing the probabilistic nature of human motion. Each gesture is modeled as a series of states with transition probabilities, allowing the algorithm to handle variations in gesture execution. HMMs are particularly effective in recognizing gestures with temporal dependencies, such as sequential hand movements. An example of HMMs is described in Park (Ex-1070). Park explains that the principles of HMM-based gesture recognition: “For each gesture, an HMM model is built and trained based on a set of collected gesture samples....We also build a garbage HMM model to filter out non-gestural movements or undefined gestures that frequently occur, e.g., ‘raising a hand to eat food’. ...At runtime, a potential gesture segmented by the sensor device is classified as one of the defined gestures or garbage. We calculate a Feature Vector (FV) series containing 18 elements, i.e., raw data, delta data, and integral data for each axis of the 3D accelerometer and the 3D gyroscope from the segmented samples. From the FV series, we use the Viterbi algorithm...to efficiently

calculate the likelihood of each gesture model. Then, the gesture model M with the highest likelihood is selected as the classified gesture.” Ex-1070, 266 (Park).

157. Machine Learning: One machine learning technique, Support Vector Machines (SVMs), classifies gestures based on feature vectors derived from sensor data. The algorithm learns to separate different gesture classes by finding the optimal hyperplane that maximizes the margin between classes. SVMs are known for their robustness and accuracy, making them suitable for gesture recognition tasks with well-defined feature sets.

158. Another machine learning technique is Neural Networks (NNs). Deep learning models, such as Convolutional Neural Networks (CNNs), are capable of learning complex patterns in gesture data, offering high accuracy and adaptability. NNs can automatically extract relevant features from raw sensor data, making them well-suited for recognizing a wide range of gestures. The flexibility of NNs allows them to adapt to new gestures and variations in execution, providing a scalable solution for gesture recognition. An approach combining a neural network with an HMM algorithm is described in Zhu’s Smart Assisted Living (SAIL) system, designed to perform hand gesture recognition. Ex-1073 (Zhu). Zhu’s algorithm is shown in Figure 2, reproduced below. *Id.*, Fig. 2 (Zhu).

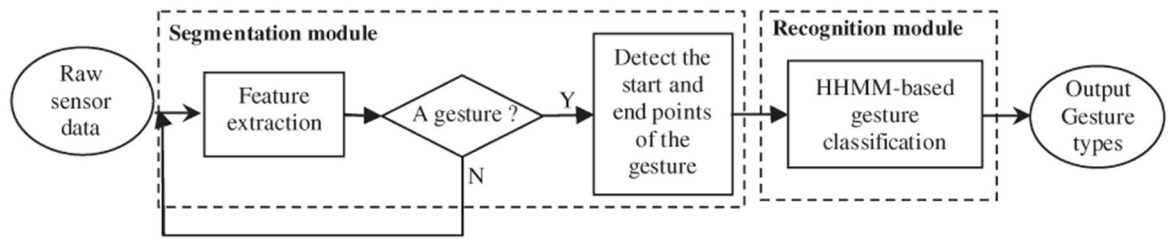


Fig. 2. Flowchart of the hand gesture recognition algorithm.

159. Dynamic Time Warping (DTW) and Dynamic Time and Space Warping (DTSW): DTW measures the similarity between two temporal sequences, accommodating variations in speed and timing. This algorithm aligns the sequences by stretching or compressing them to achieve the best match. DTW is effective for recognizing gestures with temporal variations, such as those performed at different speeds. DTSW extends the principles of DTW by not only aligning temporal sequences but also considering spatial variations in the data. This makes DTSW particularly suitable for gesture recognition tasks where both the timing and spatial configuration of the gesture are important. Examples of these techniques are described, for example, in Liu, which describes in 2009 the use of Dynamic Time Warping in uWave, an accelerometer-based personalized gesture recognition system. Ex-1074 (Liu). Figure 1 of Liu, reproduced below, illustrates the recognition process in Liu's system.

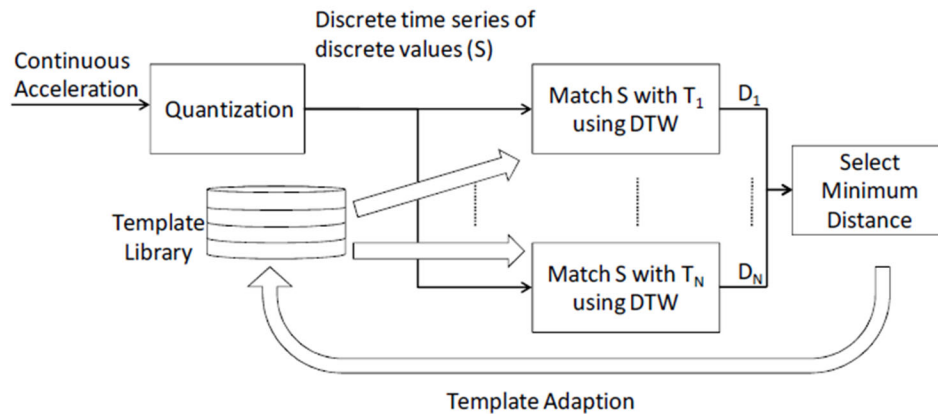


Figure 1: uWave is based on acceleration quantization, template matching with DTW, and template adaptation

160. Liu explains this recognition process as follows: “The input to uWave is a time series of acceleration provided by a three-axis accelerometer. Each time sample is a vector of three elements, corresponding to the acceleration along the three axes. uWave first quantizes acceleration data into a time series of discrete values. The same quantization applies to the templates too. It then employs DTW to match the input time series against the templates of the gesture vocabulary. It recognizes the gesture as the template that provides the best matching.” Ex-1074, 3 (Liu).

3. Multiple instances and training mode

161. In a gesture recognition system, the primary reason for using multiple examples—or instances—of gestures is to capture the inherent variability in how the same or different individuals perform the same gesture. This variability is crucial because gestures differ based on factors such as hand size, motion speed, angle, and the personal style and personal variation of the individual. For instance, a hand wave

gesture might be performed with different speeds, amplitudes, and trajectories by different people or by the same person at different times. By training the model on a diverse set of gesture examples, it learns to generalize better, enabling it to accurately recognize gestures performed by various individuals. During training, each gesture example is used to update the model's parameters—such as weights and biases in a neural network—through techniques like gradient descent. The model adjusts these parameters iteratively to minimize the error, which is the difference between the predicted gesture class and the actual gesture class, across all training examples. This iterative process helps the model become more robust and capable of recognizing gestures in a wide range of conditions. Training a gesture recognition system by using multiple instances of a gesture was well-known by 2013. For example, Sun teaches a training mode for its wrist/finger mouse, that permits assigning new command gestures for controlling an external computer. Ex-1015 ¶33 (Sun). In Sun's training mode, the user specifies a new input command, to which a new gesture should be mapped. *Id.* The user then performs the new gesture multiple times, resulting in the generation of “a composite new command gesture,” which is “added to the library of command gestures” stored on the wrist/finger mouse. *Id.* Further, in a 2008 publication, Schlömer described the training of an accelerometer-based Wii-controller to recognize “arbitrary gestures by users which can then be recalled for interacting with systems like photo browsing

on a home TV.” Ex-1075, 11 (Schlömer). Schlömer explains that “[t]he system was trained using the leave-one-out method to make sure that the models were evaluated on sequences that were not used for training....for each participant fifteen training sets each containing the five gestures were computed.” *Id.*, 14 (Schlömer).

162. In the context of gesture recognition, learning involves understanding the mean (average) and the variance (spread) of the gesture data. A fundamental concept in statistics, “[t]he most familiar property of a distribution is its mean, or expected value.” Ex-1076, 33 (Murphy). The mean gesture represents the typical or average way a gesture is performed. For example, the average motion path of a hand wave gesture might be a smooth arc moving from left to right. Another fundamental statistical concept, “[t]he variance is a measure of the ‘spread’ of the distribution.” *Id.* In gesture recognition, the variance measures how much individual gesture performances deviate from the average path, indicating the degree of variability. High variance means that the gesture performances are widely spread out from the mean, reflecting diverse ways of performing the gesture, while low variance means they are closely clustered around the mean, indicating more uniform performances. For instance, the variance in the speed and angle of a hand wave gesture might be higher if the dataset includes gestures from people with different hand sizes and motion styles. Understanding both these metrics allows the model to grasp what a typical gesture looks like and how much variation to expect, ensuring

that it can accurately recognize the gesture even when performed differently by different users.

163. Knowing the mean and variance of gestures is crucial for setting bounds or thresholds—also known as error tolerances—during training. These bounds help define what is considered a normal or typical gesture performance. For instance, in a gesture recognition system, confidence intervals (e.g., mean $\pm$ 2 standard deviations) can be established to determine the range of normal gesture variations. Gestures that fall outside these intervals might be considered outliers or misclassified gestures. For example, if the typical hand wave gesture involves a horizontal movement of the hand at a certain speed and amplitude, any gesture significantly deviating from this range might be flagged as incorrect or needing further review. Setting a maximum allowable variation, or error tolerance, permits detection of a gesture motion that is performed within the expected range. This approach helps the system to filter out false positives and negatives, improving the overall accuracy and reliability of the gesture recognition. Moreover, setting these bounds allows the system to handle edge cases where gestures are performed under unusual conditions, such as by users with unique physical characteristics.

164. During the training phase of a gesture recognition model, the model learns to map inputs (gesture features) to outputs (gesture classes) using the mean and variance to establish patterns within the gesture data. For example, the model

might learn that a hand wave typically involves a horizontal movement of the hand at a certain speed and amplitude, following a specific trajectory. In the inference phase, when the model is applied to new gesture data, it uses the learned parameters to make predictions. It compares new gesture inputs against the learned patterns to determine if they fall within the expected range of a recognized gesture. This comparison helps identify whether a new gesture is typical (nominal) or an anomaly. For instance, a new hand wave gesture will be checked against the typical features of hand waves learned during training to confirm it is indeed a hand wave. If the new gesture falls within the established bounds, it is classified as a recognized gesture; otherwise, it might be flagged for further analysis.

165. The process of learning the mean and variance from multiple gesture examples is a fundamental aspect of training gesture recognition models and was well-known to a POSITA in 2013. For example, in a 2012 publication, Trigueiros described a comparison of machine learning algorithms applied to camera-based hand gesture recognition, where the mean and variance were used as parameters for the training datasets. Ex-1077, 2 (Trigueiros).

166. In supervised learning, models are trained on labeled gesture data, learning the mean and variance for each gesture class, which aids in accurately recognizing different gestures. For instance, the model might learn the typical motion paths, speeds, and angles for gestures like swiping, pinching, or waving. In

unsupervised learning, models find patterns in gesture data without explicit labels, and techniques like clustering (e.g., K-means) rely on the mean and variance to group similar gestures together. Even in reinforcement learning, where agents learn optimal actions through trial and error, the mean and variance of rewards guide the learning process. These principles are supported by the Central Limit Theorem, which states that the distribution of sample means approaches a normal distribution as the sample size grows, and the Law of Large Numbers, which states that the sample mean converges to the true mean as the number of trials increases. Both underscore the importance of using multiple gesture examples, or instances, to accurately learn these statistical properties, ensuring the model is robust and reliable.

167. As a practical example applying these principles, a gesture recognition model can be designed to identify hand gestures for controlling a smart device, such as a television or a home automation system. The model learns the mean and variance of each gesture to make accurate recognitions. For instance, the model might learn that the mean path of a “swipe left” gesture involves a horizontal movement from right to left across the device screen, with a typical speed and distance. Training the model on a large, diverse dataset of “swipe left” gestures help it generalize better to new, unseen gestures. This dataset might include swipes performed by different individuals, under varying lighting conditions, and with different hand positions. By understanding the typical characteristics and the

expected range of variations in the “swipe left” gesture, the model can make informed recognitions and identify gestures that are unusually slow, fast, or deviate significantly from the average path, thus flagging potential misclassifications for further review. This ensures that the system remains accurate and reliable in real-world applications, providing a seamless user experience. Use of gesture recognition to control, for example, televisions or smart home devices was well-known by 2013. As an example, the Sun patent publication describes a “wrist/finger mouse” that employs gesture recognition using motion sensors and that could be also used as a “television remote control” or “a control for digital home devices.” Ex-1015 ¶48 (Sun). Rekimoto also discusses a “hand-gesture input system that is used as a remote control method,” in which “[a] wearer can control a presentation system by using hand-gestures.” Ex-1071, 22 (Rekimoto).

VI. CLAIM CONSTRUCTION

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

169. I respectfully reserve the right to offer opinions on any claim constructions proposed in this proceeding or to offer opinions on additional constructions in the district court.

VII. THE PRIOR ART IN THE APPLIED INVALIDITY GROUNDS

A. Sun (U.S. Patent Publication No. 2011/0080339) (Ex-1015)

170. Sun was filed October 7, 2009, and published April 7, 2011. I understand, as explained to me by counsel, that Sun qualifies as a prior art reference.

171. Sun discloses a wrist/finger mouse (illustrated in excerpted and annotated Figure 1, below) that is configured to identify gestures performed by a user wearing the mouse, based on acceleration data obtained by a motion sensor within the mouse. Ex-1015, Abstract.

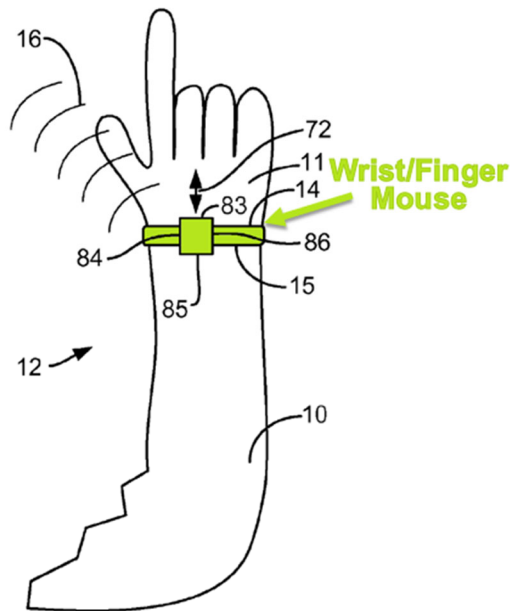


Fig. 1

172. Sun's wrist/finger mouse stores a "Command Motion Library" that maps stored gesture patterns to commands that are to be performed by an external

computer. *Id.*, ¶¶42, 44. Paragraph 42 of Sun (reproduced below with annotations) provides an example of this library:

Command Motion Library							
GESTURE NUMBER	COMMAND GESTURE NAME	MAPS TO PRESENTATION COMMAND	MOTION DETECTION PROCESS	GESTURE NUMBER	COMMAND GESTURE NAME	MAPS TO PRESENTATION COMMAND	MOTION DETECTION PROCESS
1.	Left and back movement	Left click	Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration	9.	Rotate right	Turns on wrist mouse	Rotate hand and wrist to the right (clockwise)
2.	Right and back movement	Right-click	Motion to the right and back exceeding one or both of a threshold velocity or a threshold acceleration	10.	Rotate left	Turns off wrist mouse	Rotate hand and wrist to the left (counterclockwise)
3.	Left and back movement, then right and forward movement, then left and back movement	Double click	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration	11.	Move forward	Causes image on display of computer to zoom in	Move wrist mouse away from the user generally parallel to longitudinal movement line 72
4.	Back movement, then right and forward movement, then forward movement	Begin drawing with cursor	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration	12.	Move backward	Causes image on the display of computer to zoom out	Move wrist mouse towards the user generally parallel to longitudinal movement line 72
5.	Handwriting recognition icon	Handwriting recognition	Move cursor into a hand writing icon on the computer screen and click on icon to start hand writing recognition by moving wrist mouse along letter-shaped paths.				
6.	Single tap on top side 80	Go to sleep	Vibrational movement caused by a single tap on top side 80, the vibrational movement exceeding one or both of a threshold velocity or a threshold acceleration				
7.	Tap with rhythm	For future expansion, such as for a password	Sequence of vibrational movements created by a series of taps with optional pauses, typically on a chosen side of the remote control, the vibrational movement for each tap exceeding one or both of a threshold velocity or a threshold acceleration				
8.	Tap with location	For future expansion, such as for a security code	Sets of taps/pauses with movement of wrist mouse between sets, the vibrational movement for each tap exceeding one or both of a threshold velocity or a threshold acceleration				

Memorized Gestures (Stored Gesture Patterns)

Commands Mapped to the Memorized Gestures

173. In response to identifying a performed gesture and mapping it to a stored command, Sun’s wrist/finger mouse sends a command signal instructing the external computer to perform the command. *Id.*, ¶44. For example, Figure 4C of Sun illustrates a user’s performance of a gesture that is mapped to a “double click”

command, which causes Sun's wrist/finger mouse 14 to transmit command signal 16 to external computer 18, instructing the computer to perform a double click.

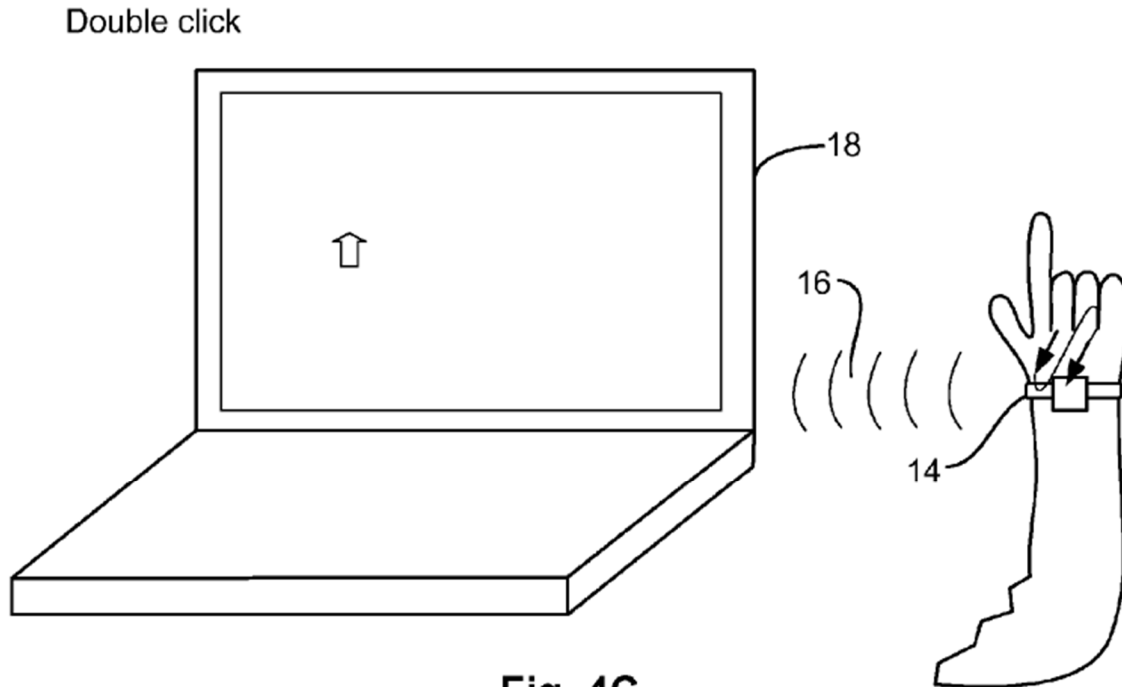


Fig. 4C

B. Kruse (U.S. Patent No. 8,031,172) (Ex-1017)

174. Kruse was filed October 12, 2007, and issued October 4, 2011. As explained to me by counsel, I understand that Kruse qualifies as prior art.

175. Kruse discloses a wearable device (e.g., a wearable haptic ring, as illustrated in annotated Figure 1A, reproduced below) that is configured to identify gestures performed by a user wearing the device, based on movements of the device sensed by an accelerometer. Ex-1017, 3:34-39.

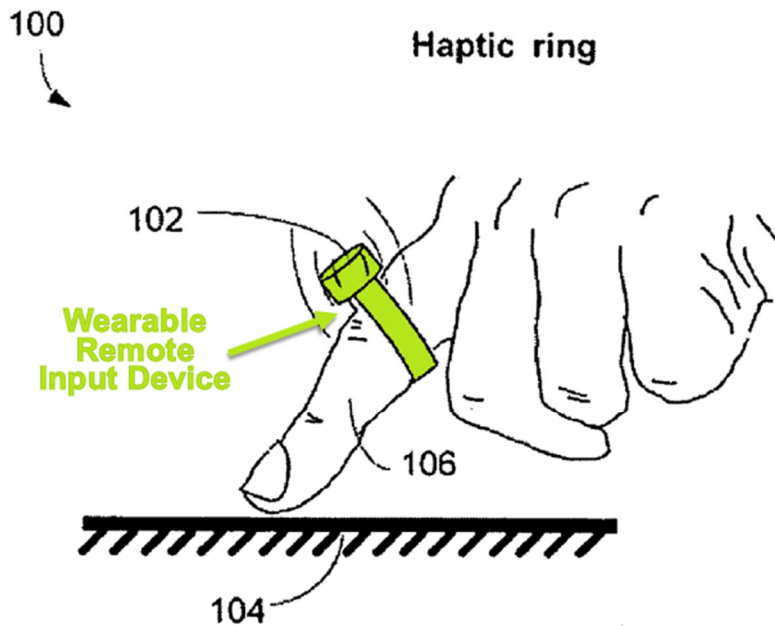


FIG 1A

Kruse explains that the wearable device identifies these gestures by filtering out “any extraneous movements, which are considered as natural hand movements as oppose[d] to command movements” performed by the user to control an external device. Ex-1017, 8:1-4.

176. After the filtering is performed, the user’s filtered movements are mapped to input commands that are transmitted to external devices, such as a PC or PDA. Ex-1017, 8:6-11. Kruse’s wearable device is additionally configured to provide haptic feedback to the user, in response to identifying an input command associated with the user’s input gesture. Ex-1017, 8:12-22. Kruse explains that this

haptic feedback is used to provide confirmation to the user of the selected input command:

Selector 324 includes one or more libraries used for filing and storing haptic data containing a list of haptic effects. In one embodiment, **the list of haptic effects is used to provide a haptic feedback to a user confirming the selected input(s)**. Each input may have a unique confirmation haptic effect. For example, different input command activates a unique haptic effect to indicate the input command. It should be noted that the library containing haptic data may be located in a host computer. Haptic output device 328 generates haptic feedback in accordance with the haptic data from selector 324. For example, a vibration effect emulates a mouse click.

Id.

VIII. DETAILED EXPLANATION OF THE UNPATENTABILITY GROUNDS

A. Ground 1: Claims 1-7, 11, 13-16, and 18-20 Are Obvious Over Sun (Ex-1015)

1. Independent Claim 1

a. Element 1[pre]: A wearable electronic device, comprising:

177. Sun teaches² the preamble of Claim 1, to the extent it is limiting.

178. Sun's wrist/finger mouse 14, illustrated in annotated and excerpted

Figure 1, below, corresponds to a "wearable electronic device":

² Throughout this Declaration I use the term "teaches," which I understand from Counsel includes both express teachings and those fairly suggested to a person of ordinary skill in the art.

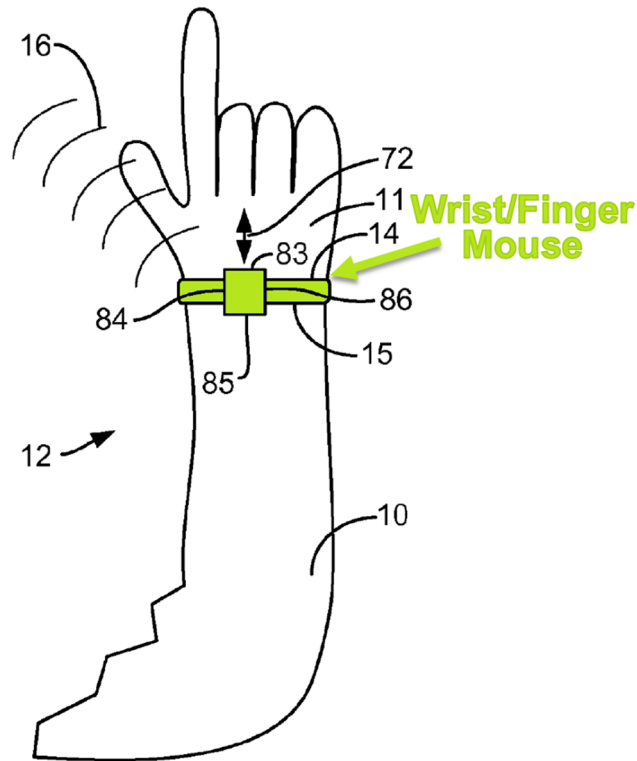


Fig. 1

179. Sun's wrist/finger mouse 14 is wearable because it is "mountable to a user at the user's hand or near the user's wrist" (Ex-1015, ¶5) using wristband 22 (*id.*, ¶17), as illustrated in annotated Figure 2, below.

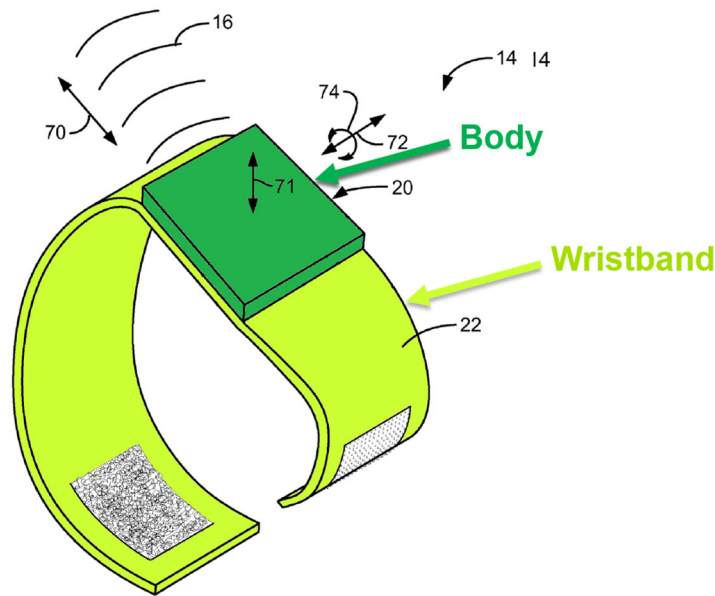


Fig. 2

180. Sun's wrist/finger mouse 14 is an electronic device because body 20 includes "microelectromechanical systems (MEMS) sensors" and electronic "motion sensitive circuitry." *Id.*, ¶¶17-18. A POSITA would have understood that MEMS sensors are "electronic," because they are made up of both electronic and mechanic components. Further, Sun explains that the motion sensor included within the wrist/finger mouse includes "accelerometers." Ex-1015, ¶¶24-25. As I explain in the Technology Background Section, a POSITA would have understood that accelerometers generate electrical signals that are proportional to the acceleration that they experience during motion. Thus, a POSITA would have understood that accelerometers are "electronic" components.

b. Element 1[a]: a housing comprising an inner surface and an outer surface;

181. Sun teaches Element 1[a].

182. Body 20 of wrist/finger mouse 14 (illustrated in modified Figure 2', below) corresponds to a housing, because “motion sensor 24 and motion sensitive circuitry 32 [are] ***housed within*** and carried by body 20.” Ex-1015, ¶17. Top 80 of body 20 is an outer surface, because, when worn by a user, it faces outward, away from the user’s body, and bottom 81 of body 20 is an inner surface, because it faces inward, towards the user’s body. This is consistent with the way the terms “inner” and “outer” are used in the '701 Patent. Ex-1001, 18:1-3 (“inner and outer walls 1612, 1614”), Figure 14A (depicting inner wall 1612 and outer wall 1614).

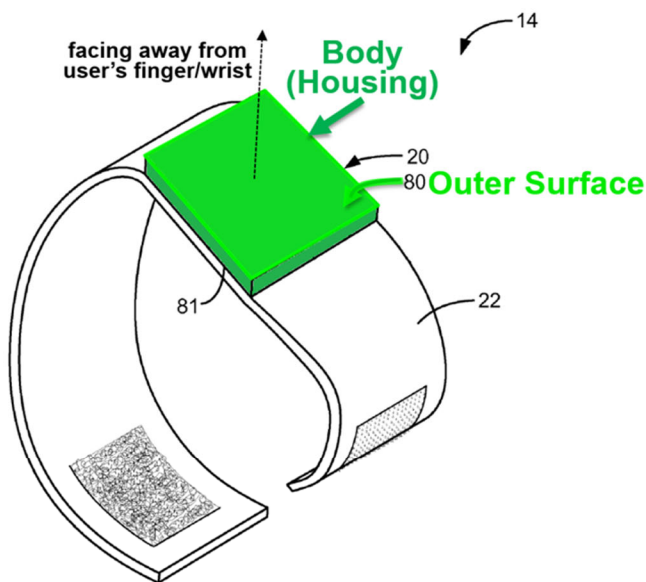


Fig. 2'

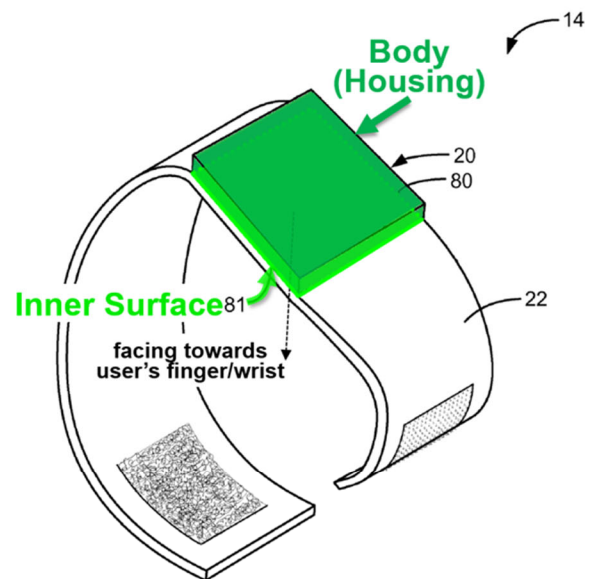
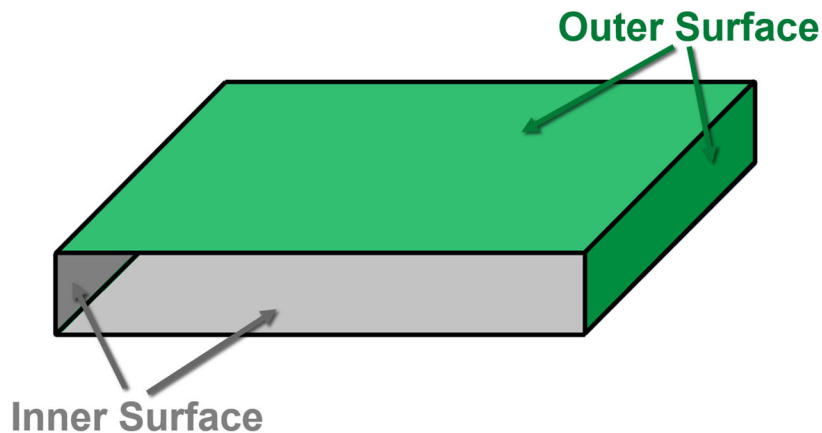


Fig. 2'

183. Alternatively, a POSITA also would have viewed the surfaces on the outside of body 20 as outer surfaces, and the surfaces inside body 20—and onto which internal components are “mounted” (Ex-1015, ¶43)—as inner surfaces, as illustrated in the cutaway diagram below.

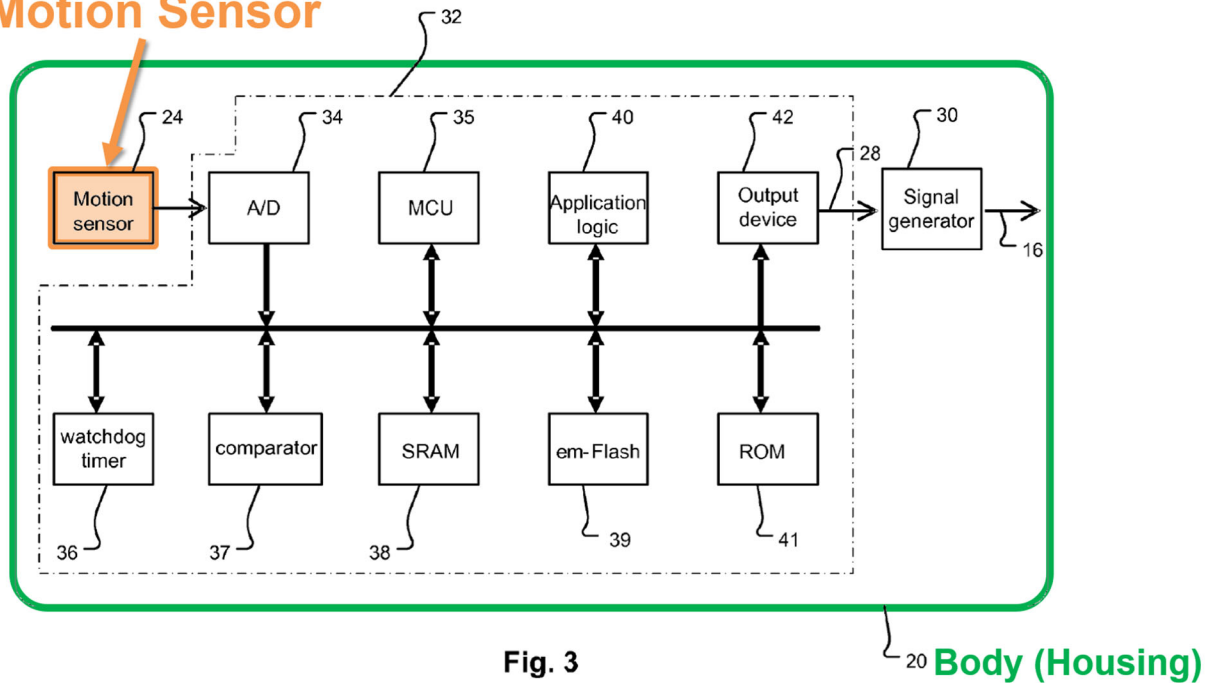


- c. **Element 1[b]: an electronic part disposed within the housing, the electronic part configured to acquire acceleration data from a user associated with the wearable electronic device; and**

184. Sun teaches Element 1[b].

185. Sun’s motion sensor 24, which is “housed within and carried by body 20” (Ex-1015, ¶17), as illustrated in annotated Figure 3, below, corresponds to an electronic part disposed within the housing.

Motion Sensor



186. Motion sensor 24 may include “microelectromechanical systems (MEMS) sensors” (Ex-1015, ¶18), packaged with “supporting circuitry such as an analog-to-digital converter, a signal processor and a communication port” (*id.*, ¶24). A POSITA would understand that MEMS sensors are “electronic” because they incorporate both electronic and mechanical components to perform their functions. Their electrical signals are processed by the supporting circuitry to provide meaningful data about the motion and orientation of the device. The inclusion of components such as an analog-to-digital converter and a signal processor further emphasizes the electronic nature of the motion sensor 24. The analog-to-digital converter transforms the analog signals generated by the accelerometers into digital form, which can then be processed by the signal processor. Further, Sun explains

that motion sensor 24 includes “accelerometers.” Ex-1015, ¶¶24-25. As I explain in the Technology Background Section, it would have been well-known to a POSITA that accelerometers generate electrical signals proportional to the acceleration that they experience. Thus, motion sensor 24 is electronic.

187. Sun’s “gesture data” corresponds to the claimed “acceleration data.” As stated above, Sun explains that motion sensor 24 includes “accelerometers” (Ex-1015, ¶¶24-25) to acquire “gesture data” (*id.*, ¶26) from a user wearing Sun’s wrist/finger mouse. These accelerometers are configured to sense movement (which may be numerically integrated into “displacement, velocity” from the original and “acceleration” components (Ex-1015, ¶21)) occurring when a user wearing wrist/finger mouse 14 performs a given “gesture” (e.g., “tapping the chosen hand of the user on a surface” (Ex-1015, ¶8)). *See also* Ex-1015, ¶21. As I explained in the Technology Background Section, it would have been well-known to a POSITA that accelerometers are sensors that measure acceleration forces along three orthogonal axes/dimensions, generating electrical signals proportional to the acceleration experienced. The accelerometers in motion sensor 24 play a crucial role in detecting and translating physical movements in three dimensions into electronic data that represents various gestures. By sensing acceleration forces, the device can accurately capture the dynamics of user interactions, enabling effective gesture recognition.

188. Sun's "gesture data" is thus "acceleration data" because it is obtained using an accelerometer and includes data indicative of accelerations of the user's hand, as experienced by the wrist/finger mouse worn thereon.

**d. Element 1[c]: one or more processors
communicatively coupled to the electronic part,
wherein the one or more processors are configured to:**

189. Sun teaches Element 1[c].

190. Motion sensor 24 ("the electronic part") is communicatively coupled to "motion sensitive circuitry 32," because it provides the sensed "gesture data" (claimed "acceleration data") to circuitry 32, as illustrated in annotated Figure 3, below. Ex-1015, ¶26.

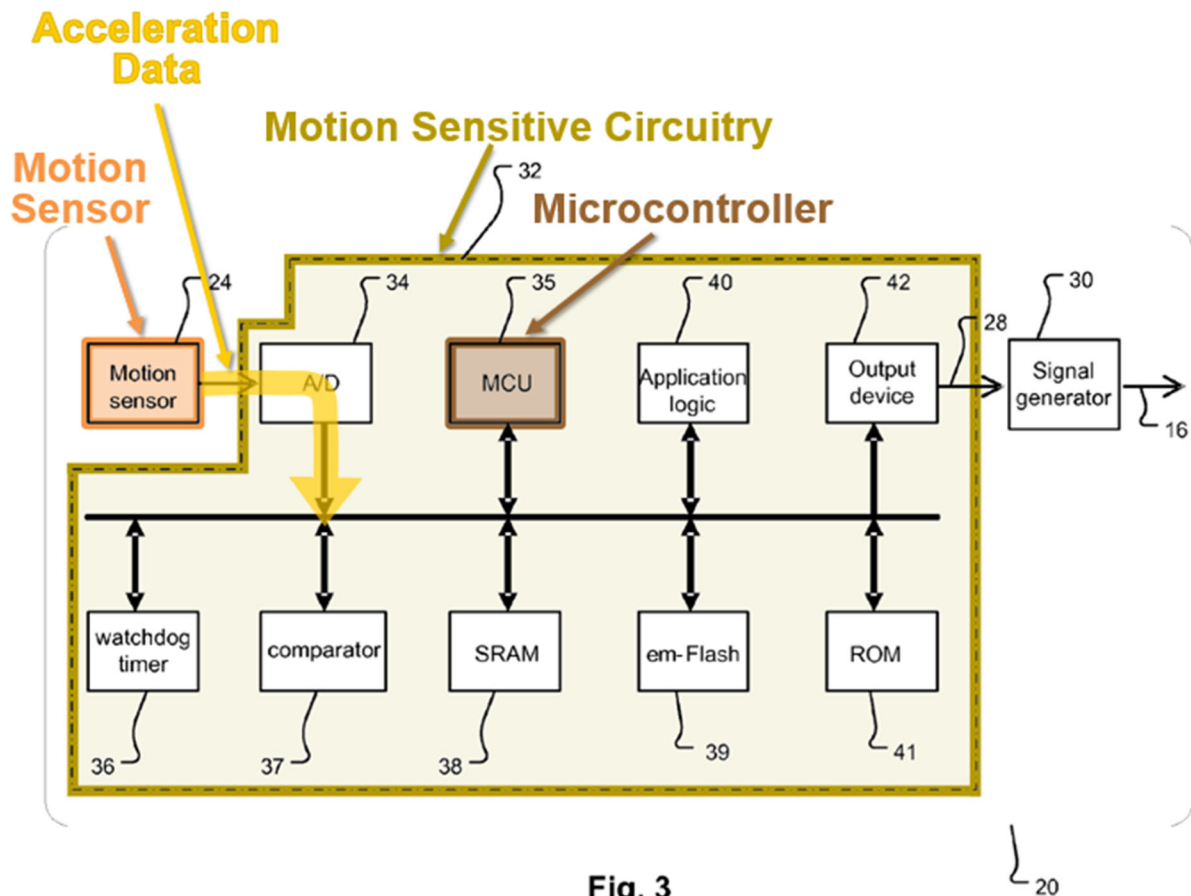


Fig. 3

191. Motion sensitive circuitry 32 includes “one or more processors,” as claimed, in the form of Sun’s MCU 35. As Sun explains, circuitry 32 includes “data processing resources” (Ex-1015, ¶26), such as “microcontroller unit MCU 35,” for “executing system firmware and coordinating processing with application logic” (Ex-1015, ¶43). A POSITA would have recognized that an MCU includes one or more processors. Indeed, Figure 24A the ’701 Patent illustrates that the one or more processors of the disclosed wearable computing device may take the form of an

“MCU,” which the figure illustrates as performing functions of the disclosed wearable computing device. Ex-1001, Fig. 24A.

192. Sun explains that MCU 35 (the claimed “one or more processors”) coordinates the processing performed by motion sensitive circuitry 32:

Motion sensitive circuitry 32 together with signal generator 30 is sometimes referred to as motion circuitry. Motion sensor 24 is coupled to analog-to-digital conversion circuit 34. Alternative systems include more than one motion sensor 24. The conversion circuit 34 is coupled to a bus on which a microcontroller unit **MCU 35 coordinates activity among a number of units, executing system firmware and coordinating processing with application logic for the gesture navigation.**

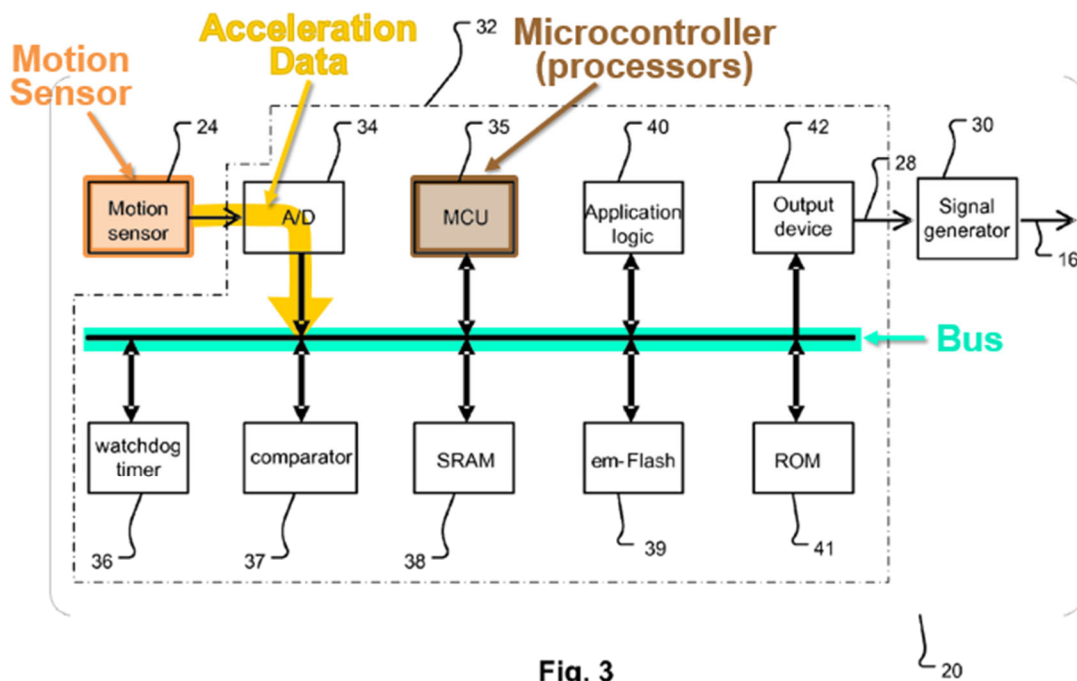
Ex-1015, ¶43. Thus, a POSITA would have understood that the functions described as being performed by Sun’s motion sensitive circuitry 32 (including the functions described as performed by the components included therein) are performed by MCU 35 “executing system firmware and coordinating processing with application logic” (Ex-1015, ¶43). Accordingly, as explained in further detail below, a POSITA would have understood that the functions recited in Elements 1[c][i] through 1[c][iv] are performed by MCU 35 (the claimed “one or more processors”).

e. Element 1[c][i]: receive the acceleration data from the electronic part;

193. Sun teaches Element 1[c][i].

194. As I explained for Element 1[b], the “gesture data” acquired by Sun’s motion sensor 24 corresponds to “acceleration data.” Sun’s motion sensitive

circuitry 32, as controlled by MCU 35 (“one or more processors”), receives this “acceleration data” from motion sensor 24 (“the electronic part”). *See, e.g.*, Ex-1015, ¶26 (“Motion sensitive circuitry 32 comprises data processing resources which provide for interpretation of the gesture data received from motion sensor 24.”), ¶36 (“gesture data” includes “acceleration”). As illustrated in annotated Figure 3, below, motion sensor 24 is coupled to “analog-to-digital conversion circuit 34,” which is connected “to a bus on which [] microcontroller unit MCU 35 coordinates activity” among the various units within circuitry 32. Ex-1015, ¶43.



195. Thus, Sun teaches that the “one or more processors” of MCU 35 receive the acceleration data sensed by motion sensor 24, through analog-to-digital circuit 34 and the bus of circuitry 32.

f. Element 1[c][ii]: identify a gesture performed by the user based at least in part on the acceleration data;

196. Sun teaches Element 1[c][ii].

197. Sun explains that “[m]otion sensitive circuitry 32 comprises data processing resources which provide for interpretation of the gesture data received from motion sensor 24” (the claimed “acceleration data”). Ex-1015, ¶26. In particular, Sun teaches that the gesture data can be analyzed by circuitry 32 (as controlled by MCU 35 (“one or more processors”) (Ex-1015, ¶43)) to obtain “displacement, velocity and acceleration data for gestures as they are performed” (Ex-1015, ¶43; *id.*, ¶36 (similar)). This displacement, velocity, and acceleration data is then stored in SRAM 38 (*id.*, ¶43), as “input sequences of data indicating gestures or component motions of gestures that include a sequence of component motions,” which can be compared “with stored sequences of data specifying the unique signatures for memorized gestures” (*id.*).

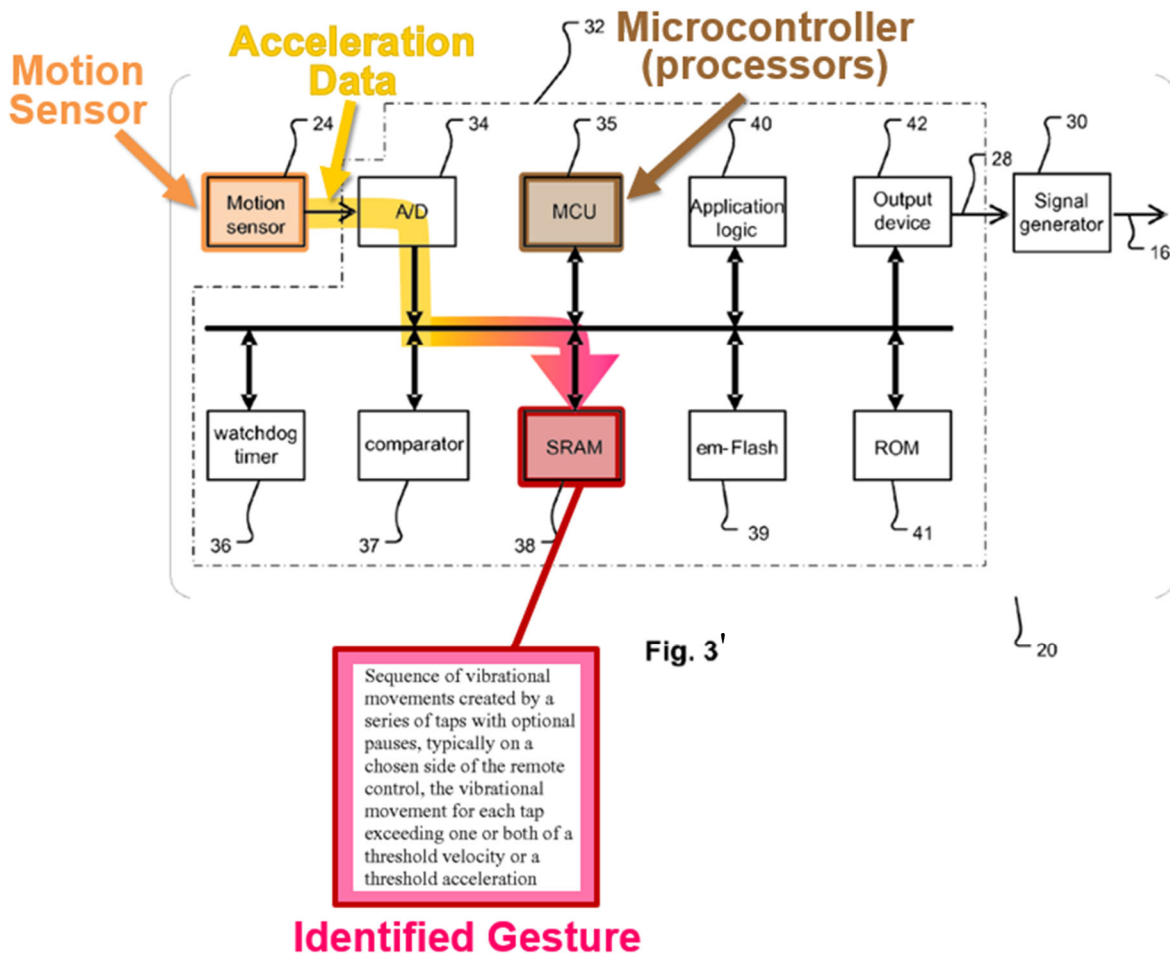
198. A POSITA would have understood that by generating displacement, velocity, and acceleration data from the gesture data received from sensor 24 (the claimed “acceleration data”) and then storing that data in SRAM 38, Sun’s motion

sensitive circuitry (as controlled by MCU 35 (“one or more processors”)) “identif[ies] a gesture performed by the user based at least in part on the acceleration data.” This process enables the system to recognize and interpret user gestures by comparing the real-time data with pre-stored gesture signatures, ensuring precise and responsive gesture control.

199. While a POSITA would have viewed Sun’s disclosure of MCU 35 generating displacement, velocity, and acceleration data from the gesture data received from sensor 24 (the claimed “acceleration data”) and then storing that data in SRAM 38 as sufficient to meet Element 1[c][ii], a POSITA would also have understood that MCU 35 would perform additional processing on the generated displacement, velocity, and acceleration data, based on the acceleration, to distinguish actual gestures performed by a user wearing Sun’s wrist/finger mouse from non-gesture movements. This processing is based on the raw and processed acceleration data and aims to distinguish actual gestures performed by a user wearing Sun’s wrist/finger mouse from non-gesture movements.

200. In particular, a POSITA would have understood that the generated displacement, velocity, and acceleration data would be processed or filtered to remove movements that do not correspond to intentional input gestures performed by the user, prior to storing it in SRAM 38 and/or comparing it against the stored sequences of data that specify unique signatures for memorized gestures. For

instance, Sun describes an example in which circuitry 32, as controlled by MCU 35 (“one or more processors”) (Ex-1015, ¶43), identifies a tapping gesture (characterized by gesture data with “high-frequency oscillation or noise”) by distinguishing such high-frequency oscillation/noise from “lower frequency motions created when wrist mouse 14 is moved along straight and/or curved paths.” Ex-1015, ¶37. In this manner, a sequence of tapping gestures may be stored in SRAM 38 for comparison/matching to a memorized gesture, as illustrated below in modified Figure 3', without storing any extraneous movements of wrist/finger mouse 14 occurring while the user performs that sequence of taps. By separating the sequence of tapping gestures from non-gesture movements, Sun's motion sensitive circuitry 32 “identif[ies] a gesture performed by the user based...on the acceleration data.” *Id.*



201. Similarly, a POSITA would have recognized that, when wrist/finger mouse 14 is attached to a user's finger/wrist, motion sensor 24 will sense a significant number of movements that do not correspond to any gestures performed by the user for the purpose of controlling external computer 18. For instance, a POSITA would not have expected a user to keep his/her finger/wrist completely still except when perform gestures. Rather, such a POSITA would have expected that the user would move his/her finger/wrist, for example, when walking or shifting positions or while talking and gesticulating. A POSITA would have understood that

attempting to match all such non-gesture movements to memorized gestures would waste significant processing resources—e.g., the processing resources associated with storing those non-gesture movements in SRAM 38 and comparing those non-gesture movements to memorized gesture patterns using comparator logic 37. A POSITA also would have understood that such unnecessary processing would unnecessarily deplete the wrist/finger mouse's battery (or otherwise waste power). Thus, the POSITA would have been motivated to filter out these non-gesture movements prior to storing the detected movements in SRAM 38, in a similar manner to that described above, for distinguishing high-frequency oscillation/noise associated with tapping gestures from “lower frequency motions created when wrist mouse 14 is moved along straight and/or curved paths.” Ex-1015, ¶37. Indeed, it was well-known in the art to perform such filtering, before further attempting to match detected gestures with stored gestures and/or otherwise map detected gestures to intended commands. For example, Kruse, which discloses a haptic ring with which a user may control an external device by performing gestures using a hand on which the ring is worn, teaches such filtering. Ex-1017, 8:1-4. In particular, Kruse explains:

Filter 322 is used to **filter any extraneous movements, which are considered as natural hand movements as oppose[d] to command input movements** such as clicking a mouse button.

Ex-1017, 8:1-4.

202. A POSITA would have understood that many such extraneous movements will be distinguishable from deliberate gesture movements based on the magnitude of the velocity/acceleration associated with the movement. In particular, a POSITA would have understood that deliberate gestures are typically characterized by fast movements and/or large accelerations (e.g., swiping in a given direction, waving back-and-forth, etc.). Indeed, Sun's examples of memorized gestures that are stored by wrist/finger mouse 14 are all characterized by motions "exceeding one or both of a threshold velocity or a threshold acceleration," as illustrated below, in an annotated excerpt of Sun's Command Motion Library. Ex-1015, ¶42.

GESTURE NUMBER	COMMAND GESTURE NAME	MAPS TO PRESENTATION COMMAND	MOTION DETECTION PROCESS
1.	Left and back movement	Left click	Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration
2.	Right and black movement	Right-click	Motion to the right and back exceeding one or both of a threshold velocity or a threshold acceleration
3.	Left and back movement, then right and forward movement, then left and back movement	Double click	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration
4.	Back movement, then right and forward movement, then forward movement	Begin drawing with cursor	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration

Memorized Gestures

203. It would not have made sense to a POSITA to store movement data (movements that were clearly not intentional gestures) in SRAM 38 and to compare that movement data to the memorized gestures stored in Sun's library, when it would not be possible for the movement data to correspond to any of the memorized gestures, because none of the components motions of the movement data correspond to high enough velocities and/or accelerations to match any of the memorized gestures.

204. Accordingly, a POSITA implementing Sun's wrist/finger mouse would have configured the device to filter out extraneous movements that do not correspond to gestures (i.e., because the velocities and/or accelerations associated with the movements fall below set thresholds), prior to storing "input sequences of data indicating gestures or component motions of gestures that include a sequence of component motions" (Ex-1015, ¶43) in SRAM 38. This filtering process ensures that only relevant gesture data is stored and processed, optimizing the device's performance and conserving its processing resources and battery life

205. In this manner, Sun's motion sensitive circuitry 32 "identif[ies] a gesture performed by the user based...on the acceleration data," by using the acceleration data to distinguish between actual gestures and non-gesture movements, and stores the identified gesture in SRAM 38.

g. Element 1[c][iii]: determine that the gesture matches a gesture pattern from a plurality of gesture patterns; and

206. As a preliminary matter, as I explained in the Technology Background Section, techniques for determining that a gesture matches a gesture pattern from a plurality of gesture patterns was well-known in the field of gesture recognition. Such well-known techniques include template matching—a simple gesture recognition technique in which input gestures are compared to pre-defined templates stored in the system.

207. Sun describes comparing identified gestures to memorized gestures stored in “a library of command [] motions” (Ex-1015, ¶31), and thus teaches Element 1[c][iii], as explained below.

208. Sun’s library of command motions is “a map database including the specifications of gestures to be used with wrist mouse 14.” Ex-1015, ¶31. The library maps specific gestures (each “a gesture pattern from a plurality of gesture patterns”) to commands for controlling an external computer. *Id.*, ¶¶41-42. For example, as illustrated in the annotated excerpt of Sun’s library, below, Sun maps the memorized gesture pattern of “Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration” to the “Left click” command that is used to instruct the external computer to respond as if the user had performed a left click using a mouse connected to the external computer.

GESTURE NUMBER	COMMAND GESTURE NAME	MAPS TO PRESENTATION COMMAND	MOTION DETECTION PROCESS
1.	Left and back movement	Left click	Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration
2.	Right and black movement	Right-click	Motion to the right and back exceeding one or both of a threshold velocity or a threshold acceleration
3.	Left and back movement, then right and forward movement, then left and back movement	Double click	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration
4.	Back movement, then right and forward movement, then forward movement	Begin drawing with cursor	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration



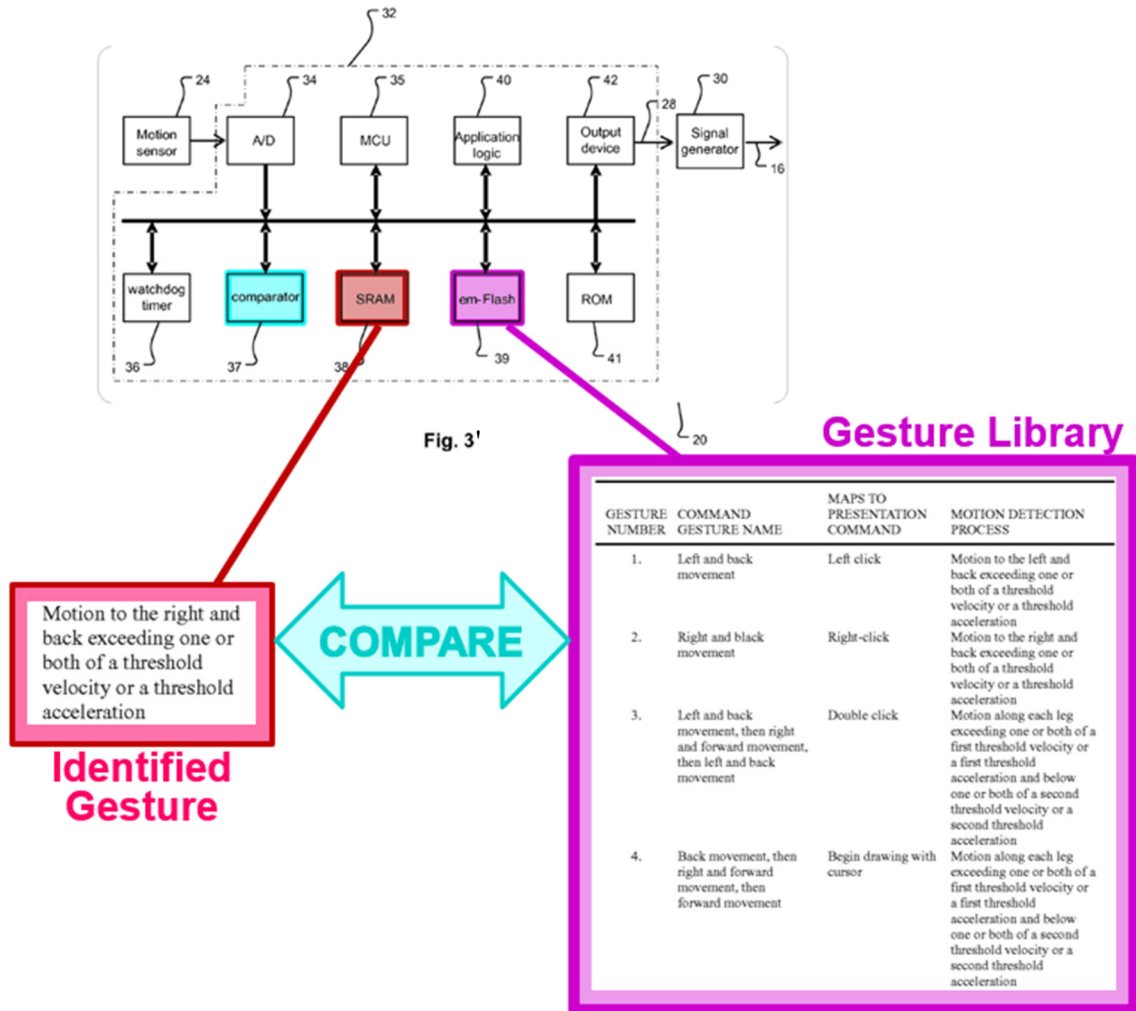
**Commands Mapped
to the Memorized
Gestures**



**Memorized Gestures
(Stored Gesture
Patterns)**

209. As explained for Element 1[c][ii], wrist/finger mouse 14 stores memorized gestures, corresponding to “input sequences of data indicating gestures or component motions of gestures that include a sequence of component motions” (each a “gesture”), in SRAM 38. Ex-1015, ¶43. Sun then uses “comparator logic 37” within motion sensitive circuitry 32, as controlled by MCU 35 (“one or more processors”) (Ex-1015, ¶43), to compare that input data stored in SRAM 38 (“gesture”) with “sequences of data specifying the unique signatures for memorized

gestures for component motions” that are stored as a database/library within embedded flash memory 39. Ex-1015, ¶43. In paragraph 42, Sun provides an example of this database/library, an excerpt of which is provided above. Ex-1015, ¶42. In this example, the set of 12 memorized gestures provided in this library correspond to the claimed “plurality of gesture patterns,” and each memorized gesture within the set of 12 memorized gestures corresponds to a claimed “gesture pattern.” By comparing the input data stored in SRAM 38 (“gesture”) to the set of memorized gestures stored within embedded flash memory 39 (“plurality of gesture patterns”), comparator logic 37 (as controlled by MCU 35 (“one or more processors”)) determines whether the detected gesture (claimed “gesture”) matches a memorized gesture (claimed “gesture pattern”), as illustrated in modified Figure 3', below. Ex-1015, ¶43; *see also id.*, ¶44 (similar).



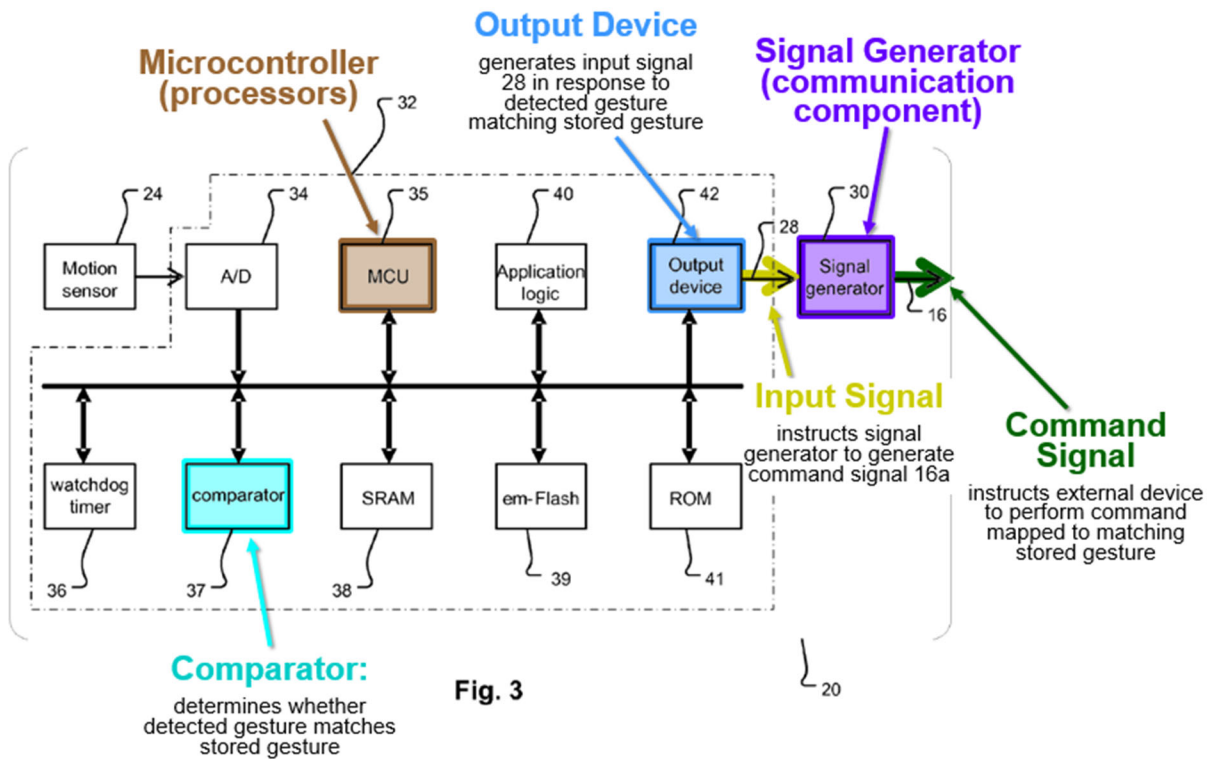
If a match is found between the identified gesture stored in SRAM 38 and a memorized gesture (“gesture pattern”) stored in Sun’s gesture library, wrist/finger mouse 14 transmits a “command signal” to the external computer, instructing the computer to perform the command that is mapped to the matching memorized gesture, as explained for Element 1[c][iv], below.

- h. Element 1[c][iv]: generate a message based at least in part on the gesture matching the gesture pattern, wherein the message is configured to cause a feedback component of the wearable electronic device to provide feedback to the user, cause a communication component of the wearable electronic device to transmit a signal to an external device, or both.**

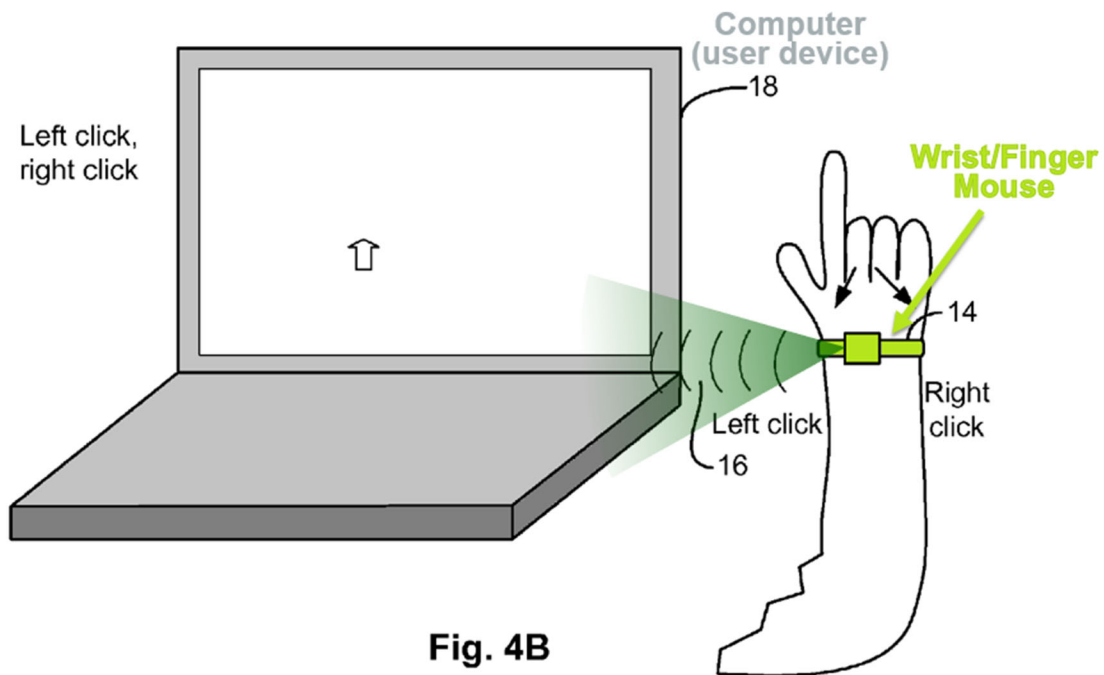
210. Sun teaches Element 1[c][iv].

211. As explained for Element 1[c][iii], Sun's motion sensitive circuitry 32 (as controlled by MCU 35 (the claimed "one or more processors")) compares detected "input sequences of data indicating gestures or component motions of gestures" to memorized gestures that are stored in a library, where each stored gesture is mapped to a specific command for controlling an external computer. Ex-1015, ¶¶43-44.

212. As illustrated in annotated Figure 3, below, in response to identifying a match, circuitry 32 (as controlled by MCU 35 (the claimed "one or more processors")) generates a message in the form of "input signal 28" (below, yellow). *Id.* Signal 28 causes signal generator 30 (below, purple) (i.e., "a communication component of the wearable electronic device") to "transmit[] a command signal 16 [(below, green)] to the signal receiver of computer 18" (i.e., "transmit a signal to an external device") (*id.*), where signal 16 (below, green) instructs computer 18 to perform the command mapped to the matching gesture stored in Sun's Command Motion Library (*id.*, ¶¶19, 41-42).



213. For example, Sun explains that “movement of wrist mouse 14 through a particular motion corresponding to a particular command, such as ‘left click,’...causes motion sensitive circuitry 32 to create a ‘left click’ input signal 28 to signal generator 30,” where “[r]eceipt of the ‘left click’ signal causes signal generator 30 [to] create a ‘left click’ command signal 16 for transmission to the signal receiver of computer 18.” *Id.*, ¶19. This is illustrated in annotated Figure 4B, below.



214. Thus, input signal 28 corresponds to the claimed “message,” which causes signal generate 30 (“a communication component”) to transmit command signal 16 (claimed “signal”) to computer 18 (“external device”).

2. Dependent Claims 2-7, 11, 13-16, and 18

- a. **Claim 2: The wearable electronic device of claim 1, wherein the one or more processors are further configured to: determining that a portion of the acceleration data satisfies an acceleration threshold, wherein identifying the gesture performed by the user is based at least in part on the portion of the acceleration data satisfying the acceleration threshold.**

215. Sun teaches Element 2[a].

216. As illustrated in the excerpted table, below, Sun’s Command Motion Library stores gestures (e.g., “Left and back movement”) associated with motion

“exceeding...a threshold acceleration.” Ex-1015, ¶42; *see also id.*, Cls. 28-31 (same).

GESTURE NUMBER	COMMAND GESTURE NAME	MAPS TO PRESENTATION COMMAND	MOTION DETECTION PROCESS
1.	Left and back movement	Left click	Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration
2.	Right and black movement	Right-click	Motion to the right and back exceeding one or both of a threshold velocity or a threshold acceleration
3.	Left and back movement, then right and forward movement, then left and back movement	Double click	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration
4.	Back movement, then right and forward movement, then forward movement	Begin drawing with cursor	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration

217. As explained for Element 1[c][ii], Sun’s motion sensitive circuitry 32 (as controlled by MCU 35 (the claimed “one or more processors”)) identifies “input sequences of data indicating gestures or component motions of gestures that include a sequence of component motions” (Ex-1015, ¶43) for storage in SRAM 38, based on a determination that the motion data exceeds a threshold acceleration and/or velocity. *See, e.g.*, Ex-1015, ¶6 (“In some examples, *the command motion* for a first command signal *exceeds* one or both of a threshold velocity or *a threshold acceleration.*”).

b. Claim 3:

- 1. Element 3[a]: The wearable electronic device of claim 1, wherein the one or more processors are further configured to: receive an indication of a training mode for gesture recognition;**

218. Sun teaches Element 3[a].

219. Sun describes a training mode that involves “training the wireless wrist mouse to recognize a command motion [(gesture)] associated with a command signal.” Ex-1015, Cl. 25, ¶8 (similar). In training mode, “[t]he user enters a name for the new command into computer 18,” and then performs “[a] new command gesture...so that wrist mouse 14 generates a new command signal 16.” Ex-1015,

¶33. Sun describes the training process as follows:

One example of training computer 18 to recognize a new command can proceed generally as follows. The user enters a name for the new command into computer 18. **A new command gesture is performed by the user** so that wrist mouse 14 generates a new command signal 16. The user then checks computer 18 to confirm receipt of command signal 16 for the new command. Assuming computer 18 has received the command signal 16 for the new command, computer 18 generates a visual display of the new command gesture for review by the user. **The user then repeats the performance of the new command and the checking of the computer until computer 18 generates and displays a composite new command gesture together with the name of the new command.** Generation of the composite new command gesture indicates that the user has sufficiently consistently performed the new command gesture to enable it to be added to the library of command gestures.

Ex-1015, ¶33.

220. In this manner, the user may create a new entry in the Command Motion Library (by assigning a new gesture to a new command (*id.*)), or modify an existing entry of the Library (by replacing the existing gesture assigned to a command with a new gesture (*id.*, ¶35)). With respect to modifying an existing entry of the Command Motion Library, Sun explains:

In some cases, a user may decide to reprogram the computer so that the computer recognizes the user's command gesture as the proper command gesture for a particular command. For example, if the user has a difficult time performing the command gesture for right-click, **the user can enter a command into the computer telling the computer that the command motion in the library for right-click is to be changed**. The procedure for changing the command motion or gesture, discussed above regarding training computer 18 to recognize a new command, can then be followed.

Ex-1015, ¶35.

221. A POSITA would have understood that Sun's wrist/finger mouse (as controlled by MCU 35 (the claimed "one or more processors")) would receive an indication of the training mode, prior to the user's performance of the new gesture. In particular, a POSITA would have understood that Sun's wrist/finger mouse would need to know whether it was in training mode to prevent it from discarding the new gesture performed by the user, after determining that it does not match any memorized gestures stored in the Command Motion Library. As Sun explains, during regular operation, if the wrist/finger mouse senses a gesture that does not match one stored in Sun's library, the gesture is ignored. Ex-1015, ¶44 ("If...there

is no appropriate correlation between the sensed movement and the library of command motions stored within motion sensitive circuitry 32, control is returned to the input of sense movement 66.”). Thus, in order to train Sun’s wrist/finger mouse to recognize a new gesture, the mouse should receive an indication of the training mode, so that the mouse does not ignore the new gesture. Furthermore, the training mode might include additional functionalities to ensure the accurate capture and storage of the new gesture. For example, the device could prompt the user to perform the new gesture multiple times to capture variations and ensure consistency. The motion sensitive circuitry, controlled by MCU 35, would then process these repetitions to create a robust gesture signature that can be reliably recognized during future use.

2. Element 3[b]: receiving additional acceleration data from the electronic part based at least in part on receiving the indication of the training mode; and

222. Sun teaches Element 3[b]. During Sun’s training mode, “[a] new command gesture is performed by the user so that wrist mouse 14 generates a new command signal 16.” Ex-1015, ¶33. Because motion sensor 24 uses accelerometers to sense the command gestures performed by the user (*id.*, ¶36), the gesture data associated with the new gesture and provided by sensor 24 to circuitry 32 (*id.*, ¶26) corresponds to “acceleration data.” In particular, as I explained for Element 1[b], it

would have been well-known to a POSITA that accelerometers are sensors that measure acceleration forces along three axes, generating electrical signals proportional to the acceleration experienced. These signals represent a comprehensive profile of the user's gesture, capturing the nuances of motion in three-dimensional space. And, as I explained for Element 3[b], circuitry 32 (as controlled by MCU 35 (the claimed "one or more processors")) receives this acceleration data after receiving an indication of the training mode. In the training mode, MCU 35 and circuitry 32 work together to analyze the incoming acceleration data, identifying unique patterns and characteristics of the new gesture. This analysis involves processing the raw acceleration data to extract meaningful features, such as changes in velocity and displacement, which define the gesture's signature.

3. Element 3[c]: generating the gesture pattern included within the plurality of gesture patterns based at least in part on the additional acceleration data.

223. Sun teaches Element 3[c]. As I explained for Element 3[a], Sun's training mode may be used to create a new entry in Sun's library, by assigning a new gesture (corresponding to the claimed "gesture pattern") to a new command signal. Ex-1015, ¶33. Sun explains that the new gesture stored in the library is "a composite new command gesture" formed using gesture data (the claimed "additional

acceleration data”) received through the user’s repeated performance of the gesture.

Id.

c. Claim 4:

- 1. Element 4[a]: The wearable electronic device of claim 3, wherein the one or more processors are further configured to: receive a user input comprises a gesture command that is to be performed at least in part by the wearable electronic device upon identifying the gesture that matches the gesture pattern,**

224. Sun teaches Element 4[a].

225. As I explained for Element 3[a], during Sun’s training mode, the user may use computer 18 to create a new entry to be stored in Sun’s Command Motion Library (by assigning a new memorized gesture (“gesture pattern”) to a new command (Ex-1015, ¶33)), or modify an existing entry of the Library (by replacing the existing memorized gesture assigned to a command with a new memorized gesture (*id.*, ¶35)). This process involves the user entering, as input, an identification of the new or existing command that is to be assigned to the new memorized gesture (i.e., the command “to be performed...upon identifying the gesture that matches the gesture pattern”). Ex-1015, ¶33 (“The user enters a name for the new command into computer 18,” and then performs “[a] new command gesture”). Because Sun’s wrist/finger mouse stores the Command Motion Library into which the new memorized gesture-assigned command entry is stored, a POSITA would have

understood that computer 18 would send the user input identifying the new/updated command to motion sensitive circuitry 32 (as controlled by MCU 35 (the claimed “one or more processors”)), as part of sending the new/updated Command Motion Library entry associated with the new/updated command to wrist/finger mouse 14. Accordingly, a POSITA would have understood that motion sensitive circuitry 32 (as controlled by MCU 35 (the claimed “one or more processors”)) receives the user input identifying the new/updated command.

226. Sun teaches that a variety of commands may be mapped to memorized gestures including, commands to be performed entirely by wrist/finger mouse 14 (e.g., a command to “caus[e] wrist mouse 14 to go into a suspension mode” (Ex-1015, ¶37)), and commands to be executed on external computer 18 (e.g., *id.*, ¶19). A POSITA would have understood that, for the commands that are to be executed on external computer 18, each command is performed “at least in part by” wrist/finger mouse 14, because the mouse’s transmission of command signal 16 to computer 18—instructing computer 18 to execute the command—is required for the command to be executed by computer 18; without wrist/finger mouse 14’s transmission of command signal 16 to computer 18, the computer would not execute the command in response to the user’s gesture indicating that user’s intention that the computer perform the command.

2. Element 4[b]: wherein generating the message is based at least in part on receiving the user input.

227. Sun teaches Element 4[b].

228. As I explained for Elements 3[a] and 4[a], during Sun's training mode, a user may create a new entry in Sun's Command Motion Library by assigning a new memorized gesture ("gesture pattern") to a new command that is to be executed in response to wrist/finger mouse 14 identifying an input gesture matching that new memorized gesture. Ex-1015, ¶33. As I explained for Element 4[a], wrist/finger mouse 14 (as controlled by MCU 35 (the claimed "one or more processors")) "receiv[es] the user input" that identifies the new command as part of receiving the new Command Motion Library entry associated with the new command from computer 18.

229. In response to receiving the new Command Motion Library entry that maps the new memorized gesture to the new command, and subsequently identifying an input gesture that matches the new memorized gesture, wrist/finger mouse 14 is configured to generate the claimed "message" in the manner described for Element 1[c][iv].

d. Claim 5:

- 1. Element 5[a]: The wearable electronic device of claim 3, wherein the additional acceleration data is associated with multiple instances of a training gesture performed by the user, the training gesture associated with the gesture, wherein generating the gesture pattern is based at least in part on the multiple instances of the training gesture,**

230. Sun teaches Element 5[a]. As I explained for Element 3[c], Sun teaches generating a “composite new command gesture” (the claimed “gesture pattern”) based on gesture data (“the additional acceleration data”) obtained through the user’s repeated performance of the new gesture (“multiple instances of a training gesture performed by the user”):

A new command gesture is performed by the user so that wrist mouse 14 generates a new command signal 16. The user then checks computer 18 to confirm receipt of command signal 16 for the new command. Assuming computer 18 has received the command signal 16 for the new command, computer 18 generates a visual display of the new command gesture for review by the user. **The user then repeats the performance of the new command** and the checking of the computer **until computer 18 generates and displays a composite new command gesture** together with the name of the new command. Generation of the composite new command gesture indicates that the user has sufficiently consistently performed the new command gesture to enable it to be added to the library of command gestures.

Ex-1015, ¶33.

- 2. Element 5[b]: wherein the one or more processors are further configured to: generate one or more error tolerances associated with the gesture pattern based at least in part on the multiple instances of the training gesture, wherein determining that the gesture matches the gesture pattern is based at least in part on the one or more error tolerances.**

231. Sun renders obvious Element 5[b].

232. As I explained in the Technology Background Section, it was well-known in the field of gesture recognition that there is inherent variability in how the same or different individuals perform the same gesture. For instance, a hand wave gesture might be performed with different speeds, amplitudes, and trajectories by the same person at different times. A POSITA would have understood that, if exact agreement was required between a stored gesture pattern and a detected gesture, significant frustration on the part of the user is likely to arise as a result of wrist/finger mouse 14 failing to identify matches between performed gestures and stored gesture patterns due to (even slight) variation between the performed gestures and the stored patterns. As an example, for stored gesture patterns involving movement along a specific direction (*see, e.g.*, Ex-1015, ¶30 (“longitudinal movements parallel to or along x-axis”), if exact agreement was required, a movement deviating by a fraction of a degree from the specified direction would not be found to match the stored gesture pattern. This rigidity would lead to

misinterpretations and failures to recognize valid gestures, diminishing the device's usability and user experience.

233. Given the inherent variability in different performances of the same gesture (even the same gesture performed by the same individual), a POSITA would have understood that matching identified gestures to stored gesture patterns, as taught by Sun, would involve the use of error tolerances. Error tolerances are crucial for practical gesture recognition systems. They ensure that minor inconsistencies do not prevent the system from correctly identifying gestures. By incorporating error tolerances, the system can accommodate these variations, ensuring reliable and consistent recognition of gestures. Moreover, the error tolerances can be dynamically adjusted based on user preferences or the specific application context. Such adaptability would allow the system to be fine-tuned for different scenarios, such as more stringent tolerances for critical control gestures and more lenient tolerances for casual or non-critical interactions.

234. As I explain in the Technology Background Section, in the context of gesture recognition, the use of error tolerances typically relies on an understanding of mean (average) and the variance (spread) of gesture data corresponding to the same gesture. The mean gesture represents the typical or average way a gesture is performed. For example, the average motion path of a hand wave gesture might be a smooth arc moving from left to right. Variance, on the other hand, measures how

much individual gesture performances deviate from this average path, indicating the degree of variability. High variance means that the gesture performances are widely spread out from the mean, reflecting diverse ways of performing the gesture, while low variance means they are closely clustered around the mean, indicating more uniform performances. For instance, the variance in the speed and angle of a hand wave gesture might be higher if the dataset includes gestures from people with different hand sizes and motion styles. Understanding both these metrics allows the gesture recognition model to grasp what a typical gesture looks like and how much variation to expect, ensuring that it can accurately recognize the gesture even when performed differently by different users or by the same user at different times. For example, the system can learn that a hand wave gesture generally involves a specific trajectory but can vary in speed and amplitude within a certain range. This understanding enables the model to tolerate natural variations in gesture performance while still correctly identifying the gesture.

235. Knowing the mean and variance of gestures is crucial for setting bounds or thresholds—also known as error tolerances—during training. These bounds help define what is considered a normal or typical gesture performance. For instance, in a gesture recognition system, confidence intervals (e.g., mean $\pm$ 2 standard deviations) can be established to determine the range of normal gesture variations. Gestures that fall outside these intervals might be considered outliers or

misclassified gestures. For example, if the typical hand wave gesture involves a horizontal movement of the hand at a certain speed and amplitude, any gesture significantly deviating from this range might be flagged as incorrect or needing further review. Setting a maximum allowable variation, or error tolerance, permits detection of a gesture motion that is performed within the expected range. This approach helps the system to filter out false positives and negatives, improving the overall accuracy and reliability of the gesture recognition. Moreover, establishing these error tolerances allows the system to adapt. For example, a gesture recognition system could adjust its error tolerances. By accounting for natural variations, the system can maintain performance without requiring users to perform gestures in an overly precise or unnatural manner

236. As explained for Element 5[a], Sun teaches using multiple instances of a new gesture, obtained through the user's repeated performance of the new gesture, which are used to generate a "composite new command gesture." Ex-1015, ¶33. As I explained in the Technology Background Section, the primary reasons for using multiple examples—or instances—of gestures is to capture the inherent variability in how the gesture is performed. Indeed, in 2013, it would have been well-known to a POSITA that using multiple instances of a gesture to learn the mean and variance of the user's performance of that gesture is a fundamental aspect of training a gesture recognition model to identify the gesture. Thus, a POSITA would have understood

that, in addition to using the user's repeated performance of a new gesture to generate a mean gesture—i.e., Sun's "composite new command gesture" (Ex-1015, ¶33)—the user's repeated performances would also be used to determine the variance associated with the user's performance of the gesture, for use in determining whether an identified gesture corresponds to the composite new gesture. In particular, by understanding the typical characteristics and the expected range of variations in the user's performance of a new, user-defined gesture, Sun's comparator 37 (as executed by Sun's MCU 35 (the claimed "one or more processors")) would be able to make informed recognitions, helping to improve the user's experience while using the wrist/finger mouse, by helping to ensure that the user's intended gestures are registered. Additionally, this approach helps to filter out unintended gestures or movements that do not fit within the established variance range. For instance, if the user accidentally moves their hand in a way that does not match the defined gesture's mean and variance, the system can recognize this as an outlier and ignore it, thereby reducing false positives.

e. Claim 6:

- 1. Element 6[a]: The wearable electronic device of claim 1, wherein the plurality of gesture patterns correspond to a plurality of gesture commands,**

237. Sun teaches Element 6[a]. As I explained for Elements 1[c][iii]-[iv], Sun's library stores mappings between a plurality of gesture patterns and associated commands for controlling an external computer. Ex-1015, ¶44.

- 2. Element 6[b][i]: wherein the one or more processors are further configured to: identify a gesture command that corresponds to the identified gesture based at least in part on determining that the gesture matches the gesture pattern, the gesture command included within the plurality of gesture commands,**

238. Sun teaches Element 6[b][i]. Sun's motion sensitive circuitry 32 (as controlled by MCU 35 (the claimed "one or more processors")) is configured to identify a command that corresponds to the identified gesture performed by the user, by determining that the user's gesture matches a memorized gesture pattern stored in Sun's library.

239. As Sun explains, circuitry 32 includes "comparator logic 37, for comparing input sequences of data indicating gestures or component motions of gestures that include a sequence of component motions, with stored sequences of data specifying the unique signatures for memorized gestures for component motions" (Ex-1015, ¶43), where those memorized gestures are stored in Sun's

Command Motion Library and are mapped to specific command signals 16 (Ex-1015, ¶44). As illustrated in the excerpted table below, each of the gestures stored in Sun’s library maps to a command:

GESTURE NUMBER	COMMAND GESTURE NAME	MAPS TO PRESENTATION COMMAND	MOTION DETECTION PROCESS
1.	Left and back movement	Left click	Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration
2.	Right and black movement	Right-click	Motion to the right and back exceeding one or both of a threshold velocity or a threshold acceleration
3.	Left and back movement, then right and forward movement, then left and back movement	Double click	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration
4.	Back movement, then right and forward movement, then forward movement	Begin drawing with cursor	Motion along each leg exceeding one or both of a first threshold velocity or a first threshold acceleration and below one or both of a second threshold velocity or a second threshold acceleration

**Commands Mapped
to the Memorized
Gestures**

**Memorized Gestures
(Stored Gesture
Patterns)**

Ex-1015, ¶42. For instance, “Motion to the left and back exceeding one or both of a threshold velocity or a threshold acceleration” maps to a “Left click” command, which is sent to external computer 18 to instruct the computer to respond as if a user had performed a left click using a mouse connected to the computer. Ex-1015, ¶19.

240. In response to determining that the user's gesture matches a memorized gesture pattern, circuitry 32 (as controlled by MCU 35 (the claimed "one or more processors")) generates a "command signal" corresponding to the command that is mapped to the memorized gesture. Ex-1015, ¶¶44, 19. For example, in the context of the "Left click" command:

Upon movement of wrist mouse 14 through a particular motion corresponding to a particular command, such as "left click," motion sensor 24 causes motion sensitive circuitry 32 to create a "left click" input signal 28 to signal generator 30. Receipt of the "left click" signal causes signal generator 30 create a "left click" command signal 16 for transmission to the signal receiver of computer 18. **The "left click" command signal 16 from signal generator 30 corresponds to the "left click" input signal created by a conventional mouse.**

Ex-1015, ¶19.

3. Element 6[b][ii]: wherein the message generated by the one or more processors is configured to perform at least a portion of the gesture command.

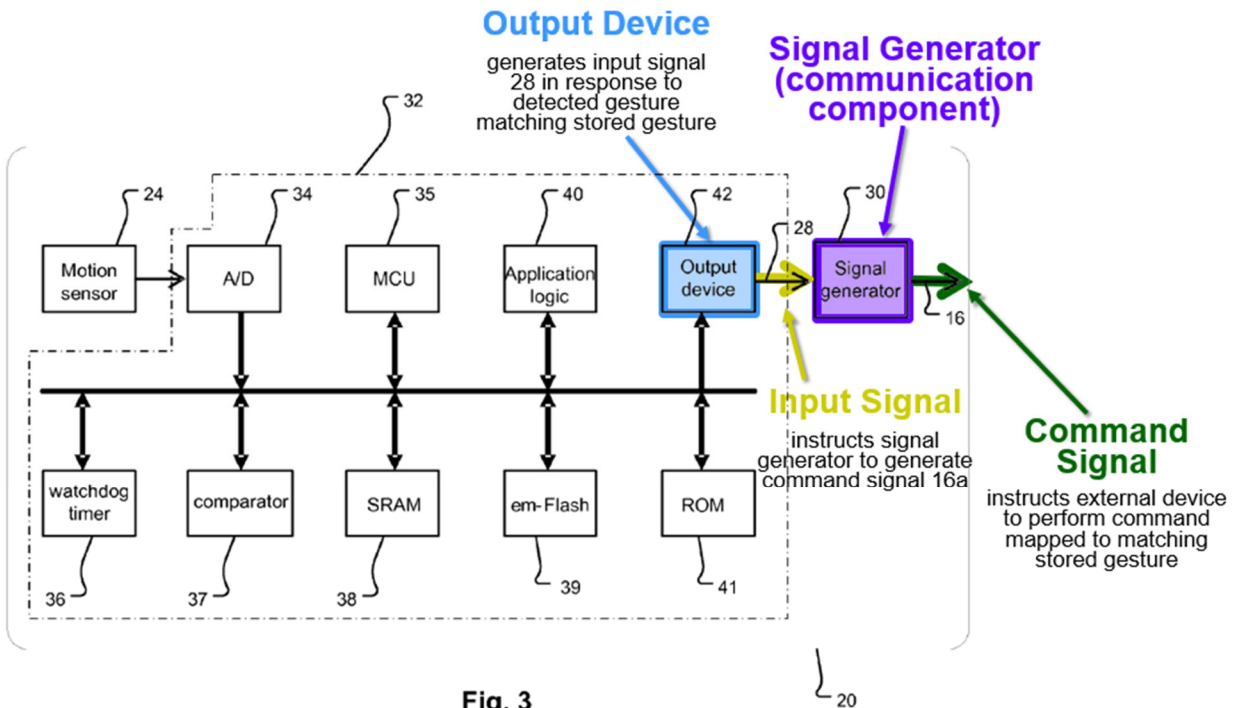
241. As I explained in Section VIII.E, in my opinion, Claim 6 is indefinite because its recitation of a "message...configured to perform...the gesture command" would not have made any sense to a POSITA, and thus fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. However, to the extent this phrase is understood to mean that the message *identifies* the gesture command, and/or transmission of the message *results in the performance of* the gesture command, Sun teaches Element 6[b][ii].

242. As I explained for Element 1[c][iv], input signal 28 corresponds to the claimed message. Signal 28 causes signal generator 30 to “transmit[] a command signal 16 to the signal receiver of computer 18” (Ex-1015, ¶44), where signal 16 instructs computer 18 to perform the command assigned to the gesture that was used to generate signal 16 (*id.*, ¶¶19, 41-42). A POSITA would have understood that signal 28 thus both identifies the command, and results in computer 18’s performance of the command.

f. Claim 7:

- 1. Element 7[a]: The wearable electronic device of claim 1, wherein the message instructs the communication component to transmit the signal to the external device,**

243. Sun teaches Element 7[a]. As I explained for Element 1[c][iv], input signal 28 corresponds to the claimed “message,” and command signal 16 corresponds to the claimed “signal.” In response to receiving signal 28, signal generator 30 (“the communication component”) “transmits [] command signal 16 to the signal receiver of computer 18.” Ex-1015, ¶44. Thus, input signal 28 instructs signal generator 30 to transmit signal 16 to the external computer. This is illustrated in Figure 3, reproduced with annotations below:



2. Element 7[b]: wherein the signal instructs the external device to selectively modify one or more parameters of the external device.

244. Sun teaches Element 7[b].

245. Signal 16 is used to control external computer 18 (Ex-1015, ¶17), by instructing the computer to perform the command assigned to the gesture that was used to generate signal 16 (*id.*, ¶¶19, 41-42). Sun provides several examples in which the command associated with signal 16 is used to selectively modify one or more parameters of external computer 18. For example, signal 16 may be used to selectively modify one or more display parameters (the claimed “one or more parameters of the external device”), by causing an image on the display of the computer to zoom in or out. Ex-1015, ¶42. A POSITA would have understood that

the zoom level of an image displayed on a display is a parameter of an external computer/display. Because a variety of different zoom levels may be chosen for an image displayed on a display (e.g., 100%, 200%, 50%), a POSITA would have understood that, by selecting one of these levels, the signal selectively modifies the zoom level parameter. A POSITA also would have understood that the selection of the zoom level corresponds to selectively modifying a parameter of the external computer/display, because it involves a selection of one parameter (zoom level) from multiple other parameters associated with the display (e.g., brightness, position of the image on the display, etc.).

246. As another example, Sun's wrist/finger mouse may be used for "temperature control for heating or cooling systems." Ex-1015, ¶46. In such situations, signal 16 would instruct the heating/cooling system to selectively modify the temperature setting stored by the system (the claimed "one or more parameters of the external device"). Because the user may choose from a variety of different temperature settings, including whether the device should function in a heating or cooling mode, a POSITA would have understood that the selection of the temperature setting corresponds to selectively modifying a parameter of the external heating/cooling system. This capability to modify parameters through gestures offers a highly intuitive and convenient way for users to interact with their environment. Instead of manually adjusting a thermostat, the user can simply

perform gestures to control the temperature, making the system more accessible and user-friendly. Furthermore, this gesture-based control can be particularly beneficial in smart home environments where multiple devices and systems are interconnected. The wrist/finger mouse can serve as a central control device, allowing the user to manage various aspects of their home environment through simple gestures.

- g. Claim 11: The wearable electronic device of claim 1, wherein the one or more processor are configured to: authenticate an identity of the user based at least in part on determining that the gesture matches the gesture pattern, wherein generating the message is based at least in part on authenticating the identity of the user.**

247. Sun teaches Claim 11.

248. Sun's wrist/finger mouse and external computer 18 may be configured such that a sequence of tap gestures "can be used to enter a password to, for example, allow access to computer 18." Ex-1015, ¶38. Here, the wrist/finger mouse (as controlled by MCU 35 (the claimed "one or more processors")) would generate input signal 28 ("the message") and command signal 16 (instructing computer 18 to allow access to the user, e.g., by including an indication of the gesture, which had been stored in the computer as corresponding to an authentication code (Ex-1015, ¶38)), in response to determining that the sequence of tap gestures performed by the user matches a predefined sequence stored in the library (i.e., "authenticating the identity of the user" based on the gesture password entered by the user). Ex-1015, ¶44.

h. Claim 13:

- 1. Element 13[a]: The wearable electronic device of claim 1, wherein the external device comprises an access node,**

249. Sun teaches Element 13[a].

250. A POSITA would have understood that an “access node” corresponds to a device providing access to a network. For example, according to the IEEE 802.11 standard, an access node, often referred to as an access point, is defined as a device that allows wireless devices to connect to a wired network using Wi-Fi, Bluetooth, or related standards. Sun’s computer 18 is thus an access node, because it is configured to provide a user with access to the internet (Ex-1015, ¶22 (use of “e-mail”)).

- 2. Element 13[b]: wherein the communication component is configured to: transmit the signal to the access node, wherein the signal comprises an indication of the gesture based at least in part on the gesture matching the gesture pattern.**

251. Sun teaches Element 13[b].

252. As I explained for Element 1[c][iv], command signal 16 (“the signal”) is generated in response to determining that the user’s gesture matches a stored gesture pattern. Signal 16 instructs computer 18 to perform the command assigned to the gesture that was used to generate signal 16 (*id.*, ¶¶19, 41-42). Thus, a POSITA

would have understood that signal 16 “comprises an indication of the gesture” through the stored correspondence between the gesture and the command (*id.*, ¶44).

253. Sun also describes situations in which signal 16 identifies the gesture performed by the user, itself. For instance, Sun explains that “[t]he tap function can [] be used to input a code, which had been programmed into computer 18, using a particular sequence of taps,” as well as “a password.” Ex-1015, ¶38. In such situations, a POSITA would have understood that signal 16 would identify the gesture-based code or password that was performed by the user, and that corresponds to the code/password programming into the computer. For example, as part of the training process by which a user is able to train to system to identify a new, user-defined gesture (Ex-1015, ¶33), when training the system to identify a password gesture, computer 18 could save the new gesture locally (in addition to transmitting a new entry for the Command Motion Library to Sun’s wrist/finger mouse 14, corresponding to the new password gesture). Then, in response to wrist/finger mouse 14 matching a detected gesture to this new password gesture, it would transmit an identification of the password gesture to computer 18 within signal 16, for authentication of the user, based on a matching between the identified password gesture and that stored locally by the computer.

- i. **Claim 14: The wearable electronic device of claim 7, wherein the external device comprises a smartphone, a door, an appliance, a keypad, an alarm system, or any combination thereof.**

254. Sun teaches Claim 14. Sun explains that the disclosed wrist/finger mouse may be used to control a variety of external devices, including “*digital home devices*,...[and] devices that operate light switches, *automatic door openers*, telephone answering machines, etc.” Ex-1015, ¶¶48, 46 (similar).

- j. **Claim 15: The wearable electronic device of claim 1, wherein the gesture comprises a pointing gesture, a snapping gesture, a tapping gesture, a knocking gesture, a clicking gesture, a swiping gesture, or any combination thereof.**

255. Sun teaches Claim 15. Sun’s wrist/finger mouse is configured to detect a variety of gestures, including “tap” gestures. Ex-1015, ¶¶8 (“tapping...comprises tapping the chosen hand of the user on a surface [or]...tapping the body of the gesture device”), 42 (mapping “tap” gestures to commands).

- k. **Claim 16: The wearable electronic device of claim 1, wherein the electronic part comprises an accelerometer, a gyroscope, a magnetometer, a vibration sensor, or any combination thereof.**

256. Sun teaches Claim 16. As explained for Element 1[b], Sun’s motion sensor 24 corresponds to the claimed electronic part. Sun explains that this motion sensor may comprise “a MEMS sensor” (Ex-1015, Abstract), which may include “accelerometers” and “gyroscopes” (*id.*, ¶24) including “capacitive or piezoelectric

vibrating gyroscopes” (*id.*, ¶25). *See also* Ex-1015, Cls. 3, 5-6 (MEMS accelerometer and gyroscope).

1. Claim 18: The wearable electronic device of claim 1, wherein the wearable electronic device comprises a finger-worn wearable device.

257. Sun teaches Claim 18. Sun explains that wrist/finger mouse 14 may be a finger-worn device: “Wrist/finger mouse 14 could also be configured for mounting to different parts of a user’s hand, typically a *finger*.” Ex-1015, ¶17.

3. Independent Claim 19

a. Element 19[pre]: A system for performing gesture recognition, comprising:

258. Sun teaches the preamble of Claim 19, to the extent it is limiting.

259. Sun discloses a system that includes wearable wrist/finger mouse 14 and external computer 18, as illustrated in annotated Figure 1, below:

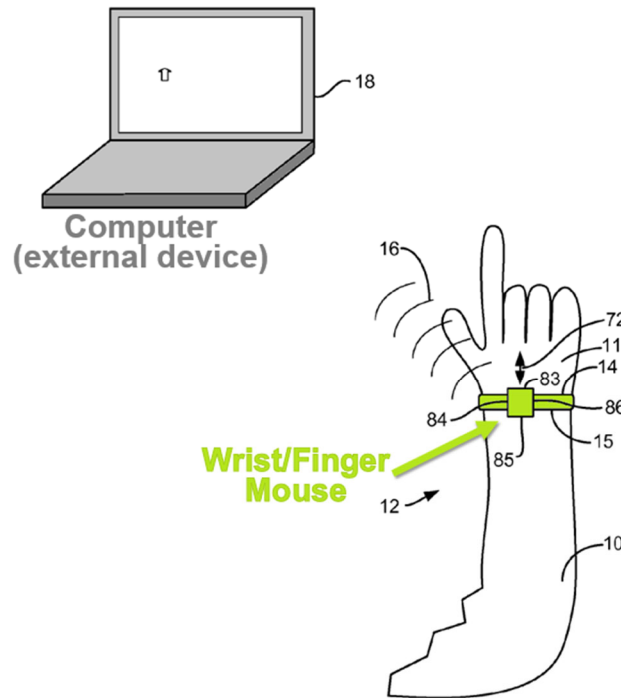


Fig. 1

260. As will be discussed for subsequent elements of Claim 19, Sun's wearable wrist/finger mouse is configured to identify gestures performed by a user wearing the device, map those identified gestures to commands, and transmit signals corresponding to those commands to control an external device. Sun's system is thus configured for performing gesture recognition.

**b. Element 19[a]: a wearable electronic device
configured to measure acceleration data from a user;**

261. Sun teaches Element 19[a]. As I explained for Element 1[pre], Sun's wrist/finger mouse 14 is "wearable" because it is "mountable to a user at the user's hand or near the user's wrist," (Ex-1015, ¶15), and it is an "electronic device" because

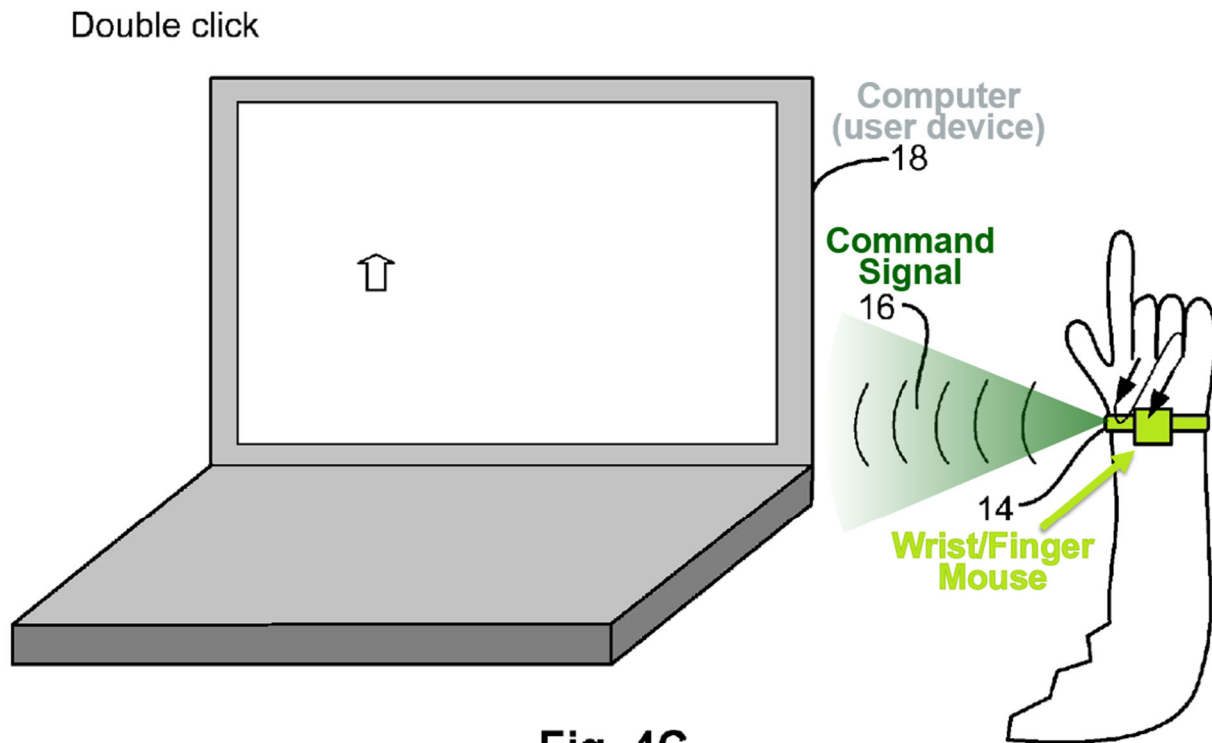
it includes motion sensor 24—in the form of “microelectromechanical systems (MEMS) sensors”—and electronic “motion sensitive circuitry” (*Id.*, ¶¶17-18).

262. As I explained for Element 1[b], Sun’s motion sensor 24 includes “accelerometers” (Ex-1015, ¶¶24-25) for measuring “gesture data” (*id.*, ¶26) from a user wearing the wrist/finger mouse, and the measured data corresponds to “acceleration data” (*see, e.g., id.*, ¶42).

c. Element 19[b]: a user device communicatively coupled to the wearable electronic device; and

263. Sun teaches Element 19[b].

264. Sun’s external computer 18 is a user device communicatively coupled to the wearable electronic device. For example, as illustrated in annotated Figure 4C, below, wrist/finger mouse 14 sends command signals 16 to computer 18, causing computer 18 to perform the associated command. Ex-1015, ¶44. Thus, wrist/finger mouse 14 is communicatively couple to computer 18.

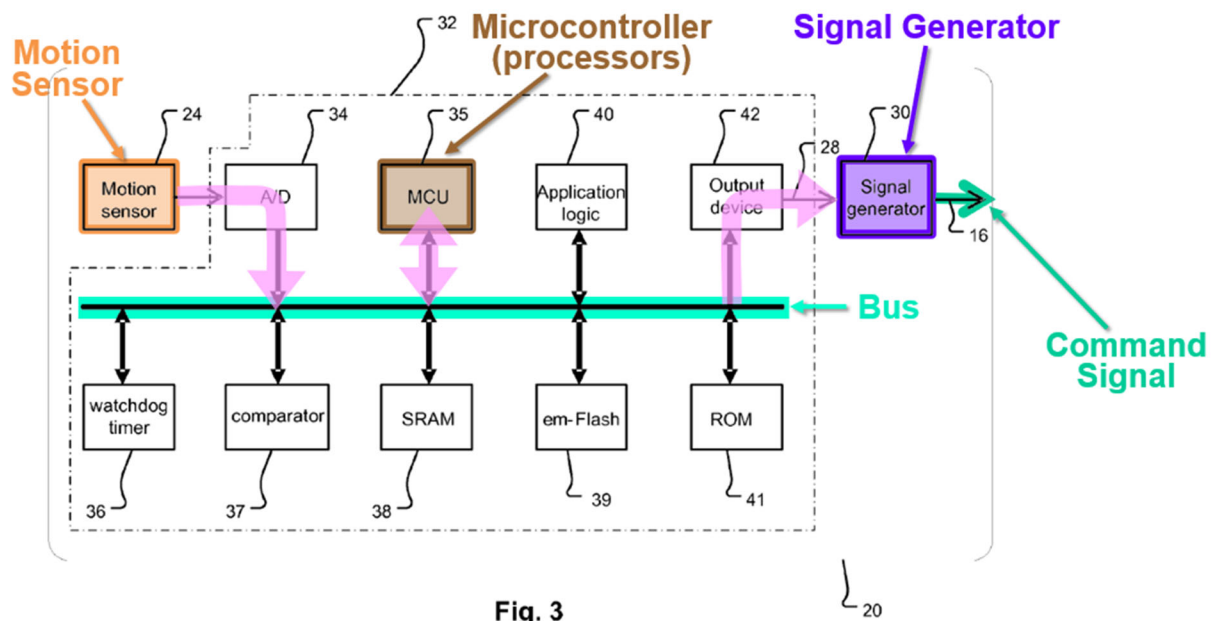


- d. **Element 19[c]: one or more processors communicatively coupled with the wearable electronic device and the user device, wherein the one or more processors are configured to:**

265. Sun teaches Element 19[c]. As I explained for Element 1[c], microcontroller (MCU) 35 (Ex-1015, ¶43) within motion sensitive circuitry 32 of Sun's wrist/finger mouse corresponds to "one or more processors."

266. Claim 20 of the '701 Patent makes clear that the claimed "one or more processors communicatively coupled with the wearable electronic device" may be included within the wearable electronic device. Ex-1001, Cl. 20 ("wherein the one or more processors are positioned within the wearable electronic device"). As illustrated in annotated Figure 2 below, MCU 35 is communicatively coupled to

motion sensor 24 (through the communication bus of motion sensitive circuitry 32), and to computer 18 (through signal generator 30, which generates command signal 16, which is sent to and received by computer 18):



- e. **Element 19[c][i]: receive the acceleration data measured from the user via the wearable electronic device;**

267. Sun teaches Element 19[c][i] for the reasons I explained for Element 1[c][i].

- f. **Element 19[c][ii]: identify a gesture performed by the user based at least in part on the acceleration data;**

268. Sun teaches Element 19[c][ii] for the reasons I explained for Element 1[c][ii].

- g. Element 19[c][iii]: determine that the gesture matches a gesture pattern from a plurality of gesture patterns; and**

269. Sun teaches Element 19[c][iii] for the reasons I explained for Element 1[c][iii].

- h. Element 19[c][iv]: generate a message based at least in part on the gesture matching the gesture pattern, wherein the message is configured to cause a feedback component of the wearable electronic device to provide feedback to the user, cause a communication component of the wearable electronic device or the user device to transmit a signal to an external device, or both.**

270. Sun teaches Element 19[c][iv].

271. As I explained for Element 1[c][iv], Sun teaches that circuitry 32 (as controlled by MCU 35 (the claimed “one or more processors”)) generates a message in the form of “input signal 28,” in response to identifying a match between a detected gesture and a memorized gesture that is stored in Sun’s library. Input signal 28 causes signal generator 30 to “transmit[] a command signal 16 to the signal receiver of computer 18” (“the user device”) (Ex-1015, ¶44), where signal 16 instructs computer 18 to perform the command that is mapped to the matching stored gesture (*id.*, ¶¶19, 41-42). Sun explains that signal 16 may be used to instruct computer 18 to “open a new e-mail.” Ex-1015, ¶22. A POSITA would have understood that email messages are stored on external email servers. Thus, a POSITA would have understood that opening a new email would involve computer

18 communicating with the external email server on which that new email is stored, in order to access the new email. Thus, Sun teaches that signal 16 (the claimed “message”) is configured to cause a communication component of computer 18 (“user device”) to transmit a signal to the email server (“external device”). In practical terms, when the user performs a gesture recognized as the command to open a new email, the wrist/finger mouse processes this gesture through its motion sensor and circuitry. Upon recognizing the gesture, circuitry 32, controlled by MCU 35, generates input signal 28. This signal is then sent to signal generator 30, which produces command signal 16. Command signal 16 is transmitted to computer 18, prompting it to send a request to the external email server to retrieve and display the new email. This chain of actions demonstrates the integration of gesture recognition technology with external communication systems, highlighting the capabilities of Sun’s wrist/finger mouse. By enabling gesture-based commands to interact with external servers and systems, the device enhances user convenience and efficiency, offering a sophisticated method of controlling and accessing digital information.

4. Dependent Claim 20:

- a. Claim 20: The system of claim 19, wherein the one or more processors are positioned within the wearable electronic device, within the user device, within one or more external servers, or any combination thereof.**

272. Sun teaches Claim 20. As explained for Element 19[c], Sun discloses that MCU 35 (corresponding to the claimed “one or more processors”) is positioned within wrist/finger mouse 14.

B. Ground 2: Claims 4 and 17 Are Obvious Over Sun In View Of Kruse

- 1. A POSITA would have been motivated to combine Sun and Kruse and would have had a reasonable expectation of success**

273. A POSITA would have been motivated to combine Sun’s and Kruse’s teachings and would have had a reasonable expectation of success at least because each relates to the same well-known technologies. Sun and Kruse are both directed to wearable devices for recognizing a user’s gestures and generating input commands for use in controlling external devices, based on the recognized gestures. Ex-1015, ¶44; Ex-1017, 7:63-8:11. Both devices may be worn on a user’s finger, and include similar components, such as motion sensors, transmitters, and processors. Ex-1015, ¶17 (“configured for mounting to...a finger”), ¶¶24-25 (motion sensor), ¶44 (“[s]ignal generator” for “transmit[ting] a command signal 16 to the signal receiver of computer 18”), ¶43 (“microcontroller unit MCU”); Ex-1017,

3:1 (“wearable haptic ring”), 3:34-36 (motion sensor), 2:63-64 (transmitter), 8:4-6 (processor).

274. Kruse teaches providing haptic feedback to a user, through the wearable ring, in order to confirm the user’s input gestures. Ex-1017, 4:14-18. In particular, Kruse’s haptic ring stores a library of “haptic effects,” where each input command that may be generated by the ring in response to detecting a user’s gesture is assigned “a unique confirmation haptic effect.” Ex-1017, 8:16-18. In response to identifying a user’s gesture and determining that it corresponds to a particular input command, haptic output device 328 within Kruse’s haptic ring “generates haptic feedback in accordance with the haptic data” assigned to the particular input command. Ex-1017, 8:20-22. Thus, Kruse’s haptic ring is able inform the user that his/her gesture has been registered as corresponding to a specific input command, by providing the user with the haptic feedback effect that is mapped to that specific input command.

275. A POSITA would have been motivated to implement Kruse’s haptic feedback selector 324 and “haptic output device 328” (Ex-1017, 8:12-22) within Sun’s wrist/finger mouse, to improve the wrist/finger mouse, by allowing it to provide haptic feedback to the user to confirm that the user’s input gestures had been recognized as corresponding to specific commands. In particular, a POSITA would have recognized that providing such feedback information to the user would improve the user’s experience when using wrist/finger mouse 14. For instance, in response

to the user performing a gesture with the intention that the performance of that gesture will cause wrist/finger mouse 14 to send signal 16 to computer 18, user confusion and/or frustration may arise if the computer does not respond in the manner it is expected to respond, in response to receive such a control signal 16. In particular, the user may be unable to determine whether he/she failed to perform the gesture correctly (in which case, the failure of the computer to respond in the expected manner was a result of no command signal 16 being sent to the computer), or he/she did in fact perform the gesture correctly, but some other issue arose (e.g., the command signal was sent to, but not received by the computer). By providing the user with haptic feedback in order to confirm to the user that he/she did indeed perform the gesture correctly, as taught by Kruse, the user's experience may thus be improved. Specifically, if the user does not receiving the feedback in response to an attempted performance of the gesture, the user will know that he/she did not perform the gesture properly, and should try again. On the other hand, in response to receiving the feedback, the user will know that the computer's failure to respond as intended, was not the result of the user's failure to perform the gesture correctly, but due to some other issue.

276. As another example, Sun explains that wrist/finger mouse 14 may include "an on-off switch," which "helps to prevent unintended generation of command signal 16 by simply moving wrist mouse 14." Ex-1015, ¶20. While use

of such an on-off switch makes sense when there are large periods of time in which a user does not intend to use the wrist mouse to control any external devices, a POSITA would have understood that, when actively engaged in using the mouse to control computer 18, repeatedly turning the mouse on/off to avoid sending unintended command signals to computer 18 is impractical. Accordingly, such a POSITA would have searched for ways to mitigate the effects of transmitting unintended commands to the computer. A POSITA would have recognized that, by providing haptic feedback to the user to confirm the input commands generated by the user's gestures, Sun's wrist/finger mouse, as modified by Kruse, would immediately notify the user when the user intentionally performed a gesture that resulting in a command signal being sent to computer 18. This information would then enable the user to quickly remediate any potential issues associated with the computer's execution of the command. For example, if the command signal resulted in the unintentional deletion of data that the user had entered into external computer 18, with the knowledge that this intentional deletion just occurred, the user may be able to reverse it. On the other, if the user isn't alerted to the unintentional command when it is generated, he/she may be unable to recover the deleted material, at a later time in the future, when its deletion is ultimately discovered. Implementing haptic feedback in Sun's wrist/finger mouse enhances the overall usability of the device. It provides clear, immediate feedback to the user, reducing uncertainty and

frustration. This improvement is particularly valuable in applications where precise and reliable gesture recognition is essential, such as controlling computer functions or other electronic devices. Moreover, the addition of haptic feedback aligns with the trend of incorporating multimodal feedback mechanisms in user interfaces. It supports more intuitive and responsive interaction, making the technology more accessible and user-friendly. By adopting Kruse's haptic feedback system, Sun's wrist/finger mouse can offer a more robust and satisfying user experience, ultimately leading to greater user confidence and efficiency.

277. As a further example, Sun teaches that a user may use a sequence of gestures as a password to allow access to computer 18. Ex-1015, ¶38. While Sun teaches the use of tap gestures followed by pauses for entry of the password, a POSITA would have understood that a variety of different gestures could be used in a sequence of gestures defining a password. Where a password is composed of multiple different gestures, by providing the user with unique haptic feedback for each distinct gesture performed by the user in the process of entering the password, Sun's wrist/finger mouse, as modified by Kruse, would enable the user to confirm that he/she has correctly performed each gesture of the sequence. A POSITA would have understood that doing so would improve the user's experience, by enabling the user to abort entry of the password as soon as the user provided an incorrect gesture (as opposed to continuing to perform the remaining gestures of the (now) incorrect

password), thereby saving the user time. Furthermore, unique haptic feedback for each gesture can enhance security by ensuring that only the intended gestures are registered. Users are less likely to make errors, and if they do, they can quickly correct them. This approach also provides a more intuitive and responsive interaction with the device, making the process of gesture-based password entry more reliable and user-friendly. Additionally, the implementation of this feature aligns with modern trends in user interface design, which prioritize immediate and clear feedback to improve user satisfaction and efficiency. By incorporating Kruse's haptic feedback system, Sun's wrist/finger mouse would not only provide an innovative method for gesture-based password entry but also set a higher standard for user interaction in wearable technology.

278. A POSITA would have had a reasonable expectation of success in combining Sun and Kruse. A POSITA would have recognized that configuring Sun's wrist/finger mouse 14 to provide haptic feedback, as taught by Kruse, would correspond to a straightforward addition of Kruse's "haptic output device 328" and haptic feedback selector 324 (Ex-1017, 8:12-22) to Sun's wrist/finger mouse. An example in which Kruse's haptic output device 328 and haptic feedback selector 324 are added to Sun's wrist/finger mouse 14 is illustrated in the below modified Fig. 3'. As can be seen in the below figure, this simply involves connecting Kruse's selector 324 to the communication bus of Sun's wrist/finger mouse 14 (and enabling Sun's

MCU 35 to control the execution of Kruse's selector 324). As illustrated in the below image, in this example, Kruse's selector 324 remains configured to instruct Kruse's device output mechanism 326 to generate haptic feedback, however a POSITA would also have understood that Sun's output device 42 could also be configured to generate the instructions sent to Kruse's device output mechanism 326. The integration of Kruse's haptic feedback system into Sun's wrist/finger mouse would provide tangible benefits. Haptic feedback offers immediate tactile confirmation to the user that their gestures have been recognized and processed, thereby enhancing user interaction and satisfaction. For instance, when a user performs a gesture to execute a command, the haptic feedback can confirm the recognition of the gesture, reducing uncertainty and improving the overall user experience. Furthermore, this combination would enhance the functionality of Sun's device in various applications, such as gesture-based password entry, temperature control, and other command executions. Users would receive real-time feedback for each gesture performed, enabling them to correct errors promptly and ensuring that intended commands are executed accurately.

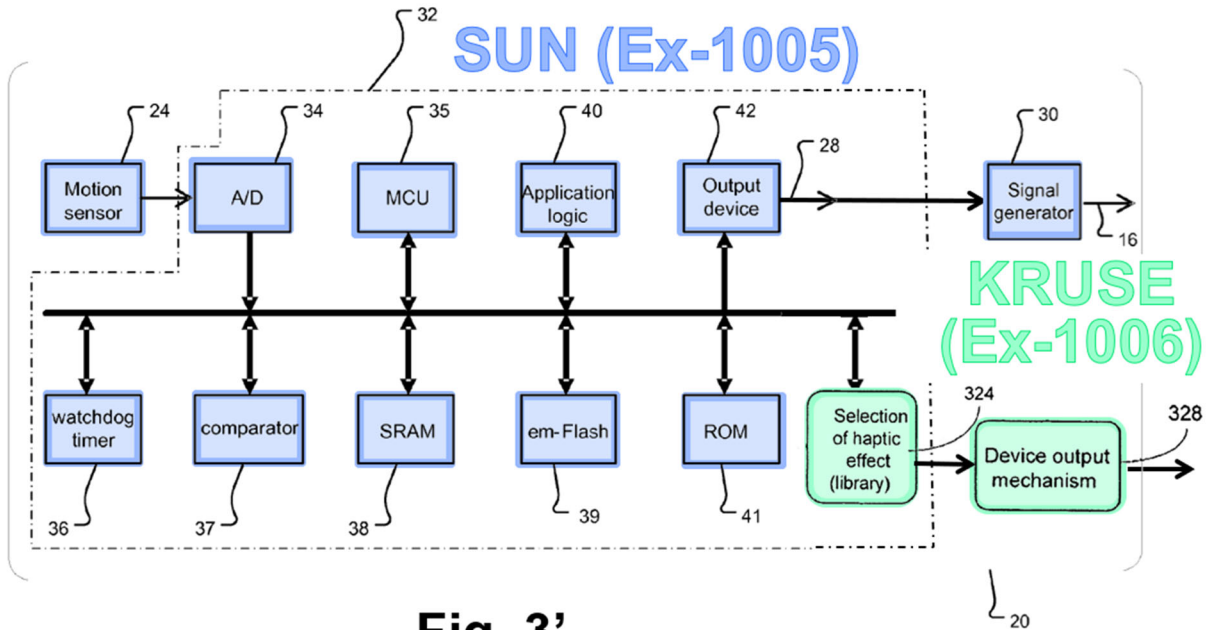


Fig. 3'

2. Dependent Claim 4:

- a. **Element 4[a]:** The wearable electronic device of claim 3, wherein the one or more processors are further configured to: receive a user input comprises a gesture command that is to be performed at least in part by the wearable electronic device upon identifying the gesture that matches the gesture pattern,

279. Sun-Kruse teaches Element 4[a].

280. As explained in Section VIII.A.2.c.1 (Ground 1, Element 4[a]), Sun teaches wrist/finger mouse 14 (as controlled by MCU 35 (the claimed “one or more processors”)) “receiv[ing] a user input [that] comprises a gesture command that is to be performed...upon identifying the gesture that matches the gesture pattern,” where the gesture command corresponds to a command to be executed by computer 18. As explained in Section VIII.B.1 (motivation to combine Sun-Kruse), a POSITA would

have been motivated to modify Sun's wrist/finger mouse to enable it to provide haptic feedback to the user, to confirm the input command to which the user's input gesture was mapped.

281. A POSITA would have understood that, when training the combined Sun-Kruse device to generate a new input command, in response to recognizing a new gesture performed by the user, in addition to receiving user input specifying the new input command to be assigned to the new gesture, the device would also receive user input specifying a haptic effect to be assigned to the new gesture (Ex-1017, 8:12-22). Notably, Kruse teaches the use of "one or more libraries used for filing and storing haptic data containing a list of haptic effects." Ex-1017, 8:12-13. A POSITA would thus have understood that, when Sun's wrist/finger mouse 14 is modified according to Kruse's teachings, in addition to storing mappings between memorized gestures and commands, Sun's Command Motion Library would also store mappings between memorized gestures/associated commands and corresponding haptic feedback effects. Thus, a POSITA would have understood that, as part of the training process for learning a new user-specific gesture, the combined Sun-Kruse device would be configured to receive user input specifying a haptic effect to be assigned to the new gesture, in the same manner as Sun's device receives user input specifying a new command assigned to the new gesture. This process would mirror how Sun's device receives user input specifying a new

command to be assigned to the new gesture. The haptic feedback serves as an additional layer of confirmation, enhancing the user's interaction with the device. The combined new command and new haptic feedback effect could be considered a new combined command. This dual feedback mechanism allows the user not only to execute commands through gestures but also to receive immediate tactile confirmation that the command has been processed correctly. This integration significantly enhances the usability of the wrist/finger mouse by providing clear, real-time feedback to the user, thus reducing errors and increasing confidence in the device's functionality.

282. Thus, the combined Sun-Kruse device is configured to receive user input identifying both the new input command and the new haptic effect (collectively, "a gesture command"), where the new haptic effect is to be performed by the wearable device in response to determining that a user's gesture matches the new gesture ("gesture pattern") (Ex-1017, 8:12-22). Thus, the claimed "gesture command" (both the new input command and the new haptic effect) is to be performed in part by the wearable electronic device.

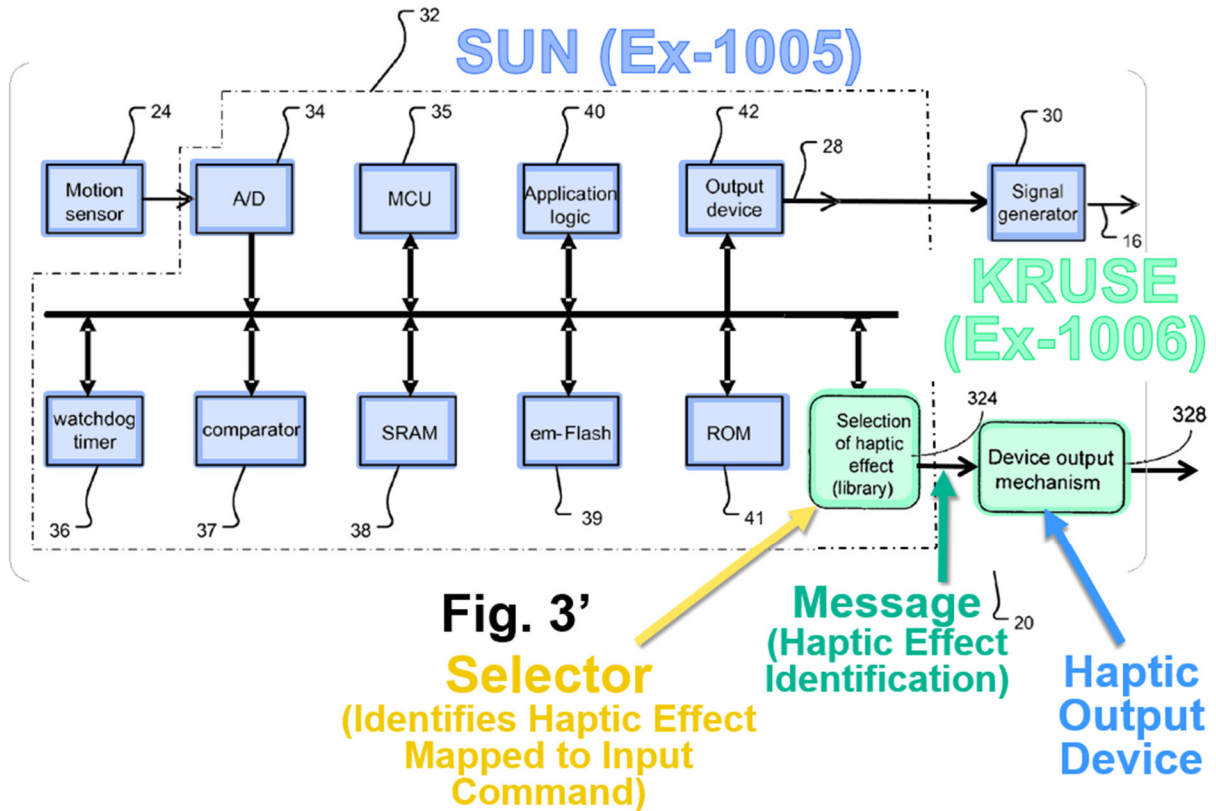
b. Element 4[b]: wherein generating the message is based at least in part on receiving the user input.

283. Sun-Kruse teaches Element 4[b], for the reasons explained in Section VIII.A.2.c.2 (Ground 1, Element 4[b]).

3. Dependent Claim 17: The wearable electronic device of claim 1, wherein the feedback comprises visual feedback, audio feedback, haptic feedback, or any combination thereof.

284. Sun-Kruse teaches Claim 17. As explained in Section VIII.B.1 (motivation to combine Sun and Kruse), Sun's wrist/finger device, modified by Kruse, is configured to provide haptic feedback to the user.

285. As illustrated in the annotated Figure below, in response to the modified wrist/finger device identifying an input command assigned to the user's input gesture, selector 324 sends a message to "[h]aptic output device 328" with "haptic data" corresponding to the assigned haptic effect. Ex-1017, 8:20-21. Haptic output device 328 then "generates feedback in accordance with th[at] haptic data from selector 324." *Id.* For example, haptic output device 328 may generate "a vibration effect" to confirm a mouse click command. Ex-1017, 8:21-22.



286. Thus the message sent from selector 324 to haptic output device 328 corresponds to “a message configured to cause a feedback component of the device to provide feedback to the user,” wherein the feedback is “haptic feedback,” because it causes haptic output device 328 (“a feedback component”) to generate haptic feedback that is provided to the user through wearable device 102/302.

C. Ground 3: Claims 1, 6-7, and 13-20 Are Obvious Over Kruse

1. Independent Claim 1

- a. **Element 1[pre]: A wearable electronic device, comprising:**

287. Kruse teaches the preamble of Claim 1, to the extent it is limiting. Kruse’s wearable remote input device 102 corresponds to a “wearable electronic

device.” Kruse teaches several different embodiments of its wearable remote input device, including a wearable haptic ring, illustrated in annotated Figure 1A, below:

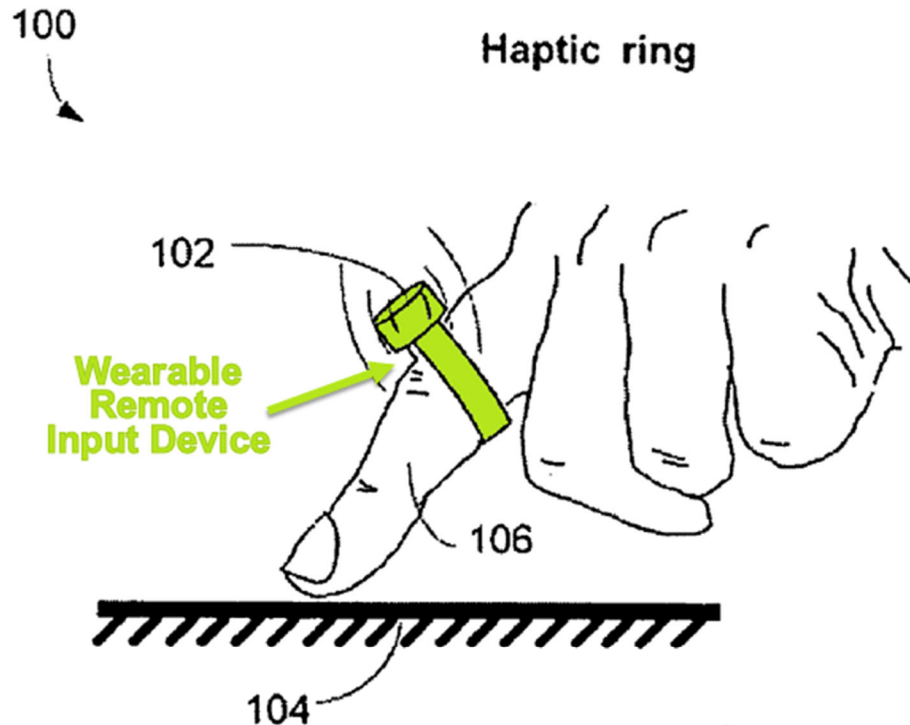


FIG 1A

288. Device 102 is wearable because it can “be attached to a finger or a hand or any parts of a body.” Ex-1017, Abstract. When in the form of “[w]earable haptic ring 102,” as illustrated above, it “is designed and structured in a ring shape that can be worn and/or fit on a finger.” Ex-1017, 3:8-11.

289. Device 102 is an “*electronic* interface device[.]” Ex-1017, 1:6-7. For instance, device 102 may include a piezoelectric sensor/actuator. Ex-1017, 3:48-

4:2. A POSITA would have understood that piezoelectric sensors are electronic components that convert a mechanical or thermal input into an electrical signal. Device 102 includes additional electronic components in the form of a wireless transmitter (*id.*, Cl. 1), and internal processing components (*id.*, 9:27-34). The piezoelectric sensor allows the device to detect and convert physical changes into electrical signals, which are then processed by the internal components. The processed data can be transmitted wirelessly to other devices or systems, enabling interaction and control. For instance, in a practical application, device 102 could be used in a wearable device that monitors physiological parameters. The piezoelectric sensor could detect changes in muscle contractions or heartbeats, converting these mechanical changes into electrical signals. The internal processing components would analyze this data to extract meaningful metrics, which could then be transmitted wirelessly.

b. Element 1[a]: a housing comprising an inner surface and an outer surface;

290. Kruse teaches Element 1[a].

291. Device 102 includes various components, including “a sensor, a filter, an input identifier, and a transmitter.” Ex-1017, 2:52-55. A POSITA would have understood that such components would be housed within a housing of device 102.

For instance, Figure 1A, reproduced with annotations below, illustrates such a house for the haptic ring embodiment of device 102:

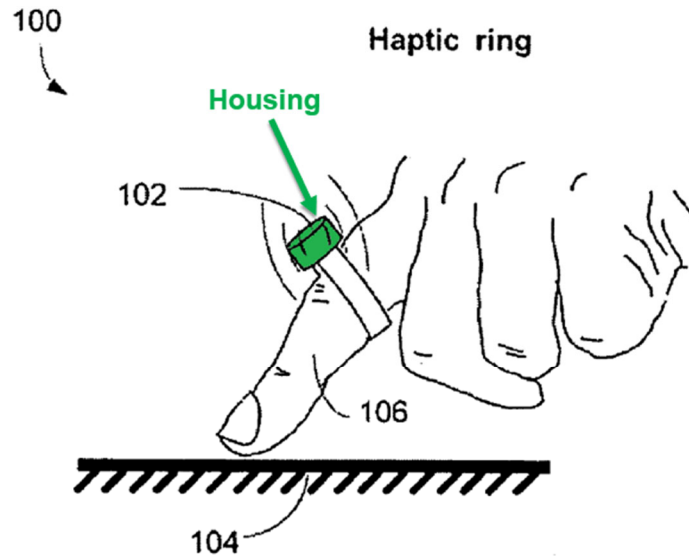
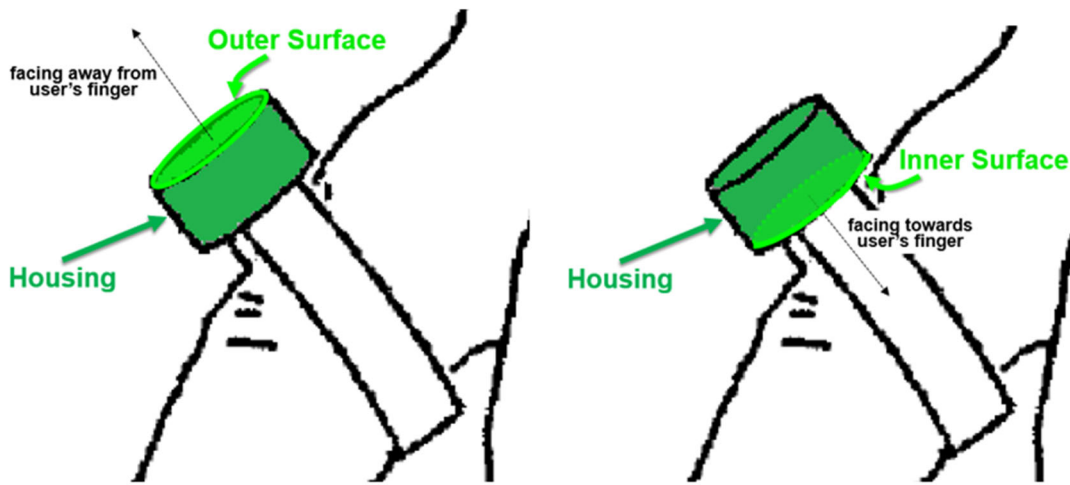


FIG 1A

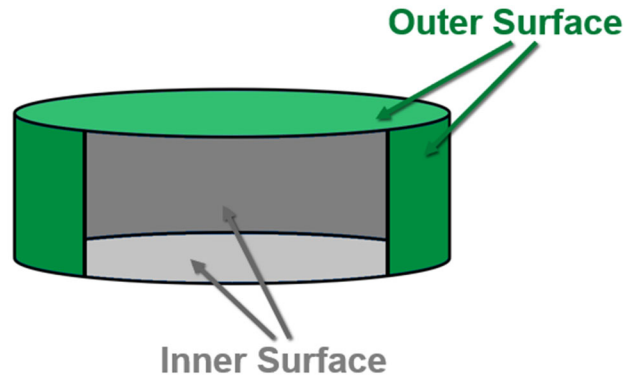
292. As illustrated in the images below (corresponding to modified versions of Figure 1A), when worn on a finger, the housing of Kruse's haptic ring includes "an outer surface" (i.e., a surface that faces outward, away from the finger), and "an inner surface" (i.e., a surface that faces inward, towards the finger).



This is consistent with the way the terms “inner” and “outer” are used in the '701 Patent. Ex-1001, 18:1-3 (“inner and outer walls 1612, 1614”), Figure 14A (depicting inner wall 1612 and outer wall 1614).

293. Alternatively, a POSITA also would have viewed the surfaces on the outside of haptic ring 102's housing as corresponding to outer surfaces, and the surfaces inside the housing as corresponding to inner surfaces, as illustrated in the cutaway diagram below. Such a POSITA would have understood that the internal components of the haptic ring would be mounted on the inner surface of the housing.

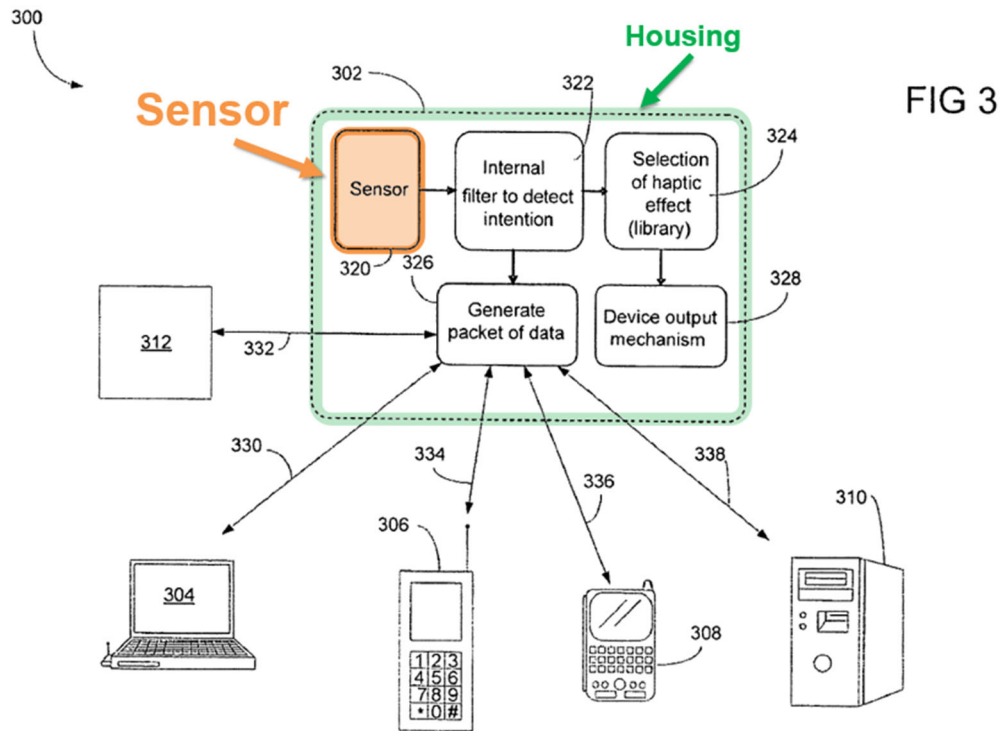
Id.



- c. **Element 1[b]: an electronic part disposed within the housing, the electronic part configured to acquire acceleration data from a user associated with the wearable electronic device; and**

294. Kruse teaches Element 1[b].

295. Kruse's sensor 320 corresponds to an electronic part disposed within the housing. As explained for Element 1[a], a POSITA would have understood that the components of Kruse's device 102/302 would be housed within a housing. These internal components include sensor 320, as illustrated in annotated Figure 3, below:



296. Sensor 320 may be a piezoelectric sensor (3:48-4:2), configured to generate electronic signals based on sensed parameters. A piezoelectric sensor generates electronic signals based on sensed parameters, such as mechanical stress or thermal changes. When a mechanical force or thermal input is applied to the piezoelectric material, it generates an electrical charge in response, effectively converting the physical stimulus into an electronic signal. Thus, a POSITA would have understood that sensor 320 is electronic.

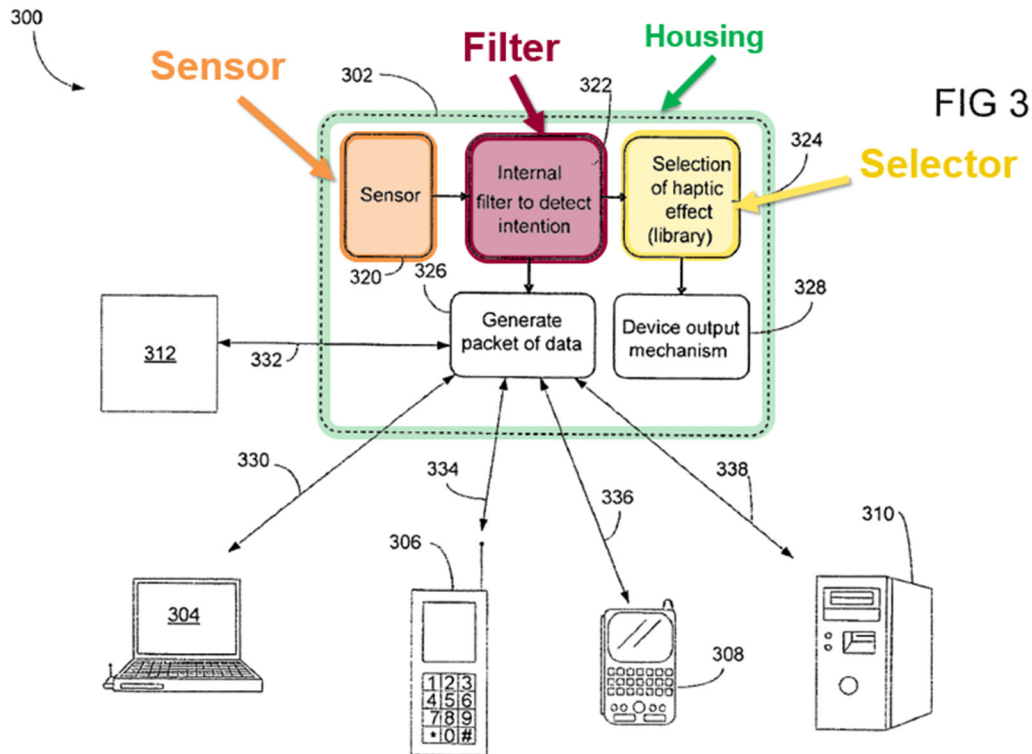
297. Sensor 320 corresponds to/includes an “acceleration” sensor (*id.*, 8:23-27), for “sensing the movement of the finger” to which device 102 is attached (Ex-1017, 1:37-40). *See also id.*, 3:34-36 (“When finger 106 touches or collides with surface 104, wearable haptic ring 102 senses the motion or movement using an

accelerometer or similar sensor(s).”). As I explained in the Technology Background Section, it would have been well-known to a POSITA that accelerometers are sensors that measure acceleration forces along three axes, generating electrical signals proportional to the acceleration experienced. Thus, a POSITA would have understood that data associated with a user’s finger movements and acquired by an accelerometer corresponds to “acceleration data from [the] user.”

**d. Element 1[c]: one or more processors
communicatively coupled to the electronic part,
wherein the one or more processors are configured to:**

298. Kruse teaches Element 1[c].

299. As illustrated in annotated Figure 3, below, in addition to sensor 320, wearable interface device 302 includes “an internal filter 322” and “a selector 324.”
Ex-1017, 7:63-65.

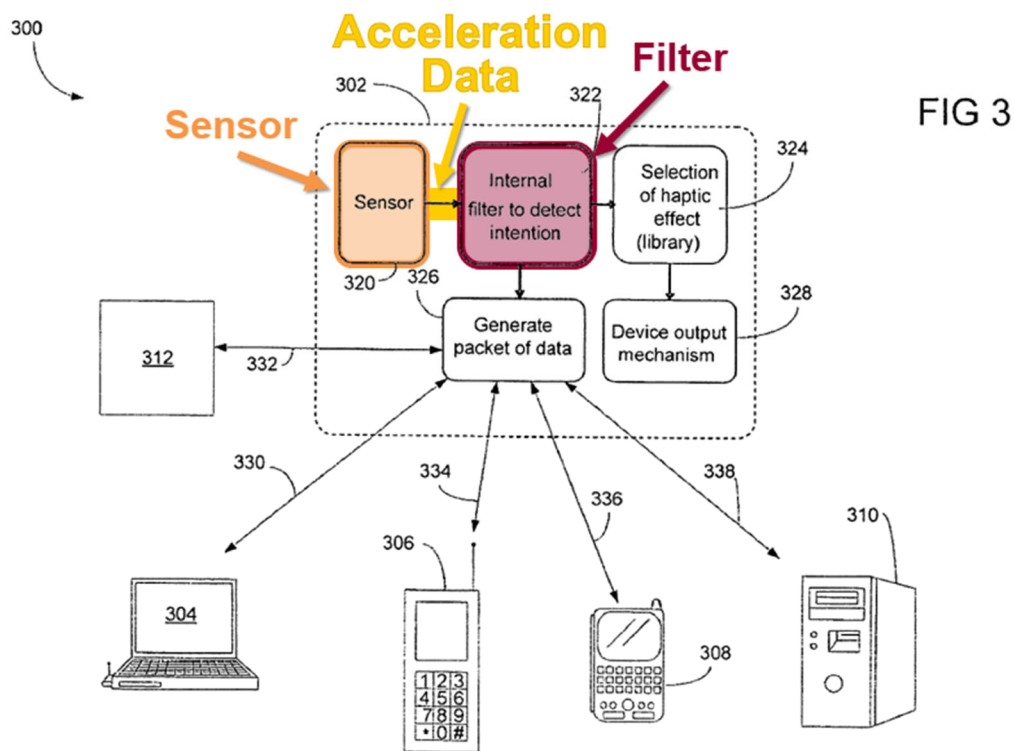


300. Kruse explains that these components may correspond to “computer executable instructions” (Ex-1017, 9:24-34) implemented by a processor (*id.*, 8:4-6). Thus, a POSITA would have understood that the functions performed by these components are performed by “one or more processors,” as claimed. As illustrated above, filter 322 is communicatively coupled to sensor 320 (“the electronic part”). Thus, the processor executing the instructions for performing the functions of filter 322 is communicatively coupled to sensor 320 (“the electronic part”).

e. Element 1[c][i]: receive the acceleration data from the electronic part;

301. Kruse teaches Element 1[c][i].

302. As explained for Element 1[b], sensor 320 (“the electronic part”) acquires movement data (“acceleration data”) associated with the movements of a user’s finger on which device 102/302 is worn. As illustrated in annotated Figure 3, below, filter 322 receives this movement data from sensor 320. *See also* Ex-1017, 8:1-4 (filter 322 is configured for subsequent processing of the movement data acquired by sensor 320).



f. Element 1[c][ii]: identify a gesture performed by the user based at least in part on the acceleration data;

303. Kruse teaches Element 1[c][ii].

304. Filter 322 is configured to identify a gesture performed by the user based on the movement data (“acceleration data”) received from sensor 320. Specifically, “[f]ilter 322 is used to filter any extraneous movements, which are considered as natural hand movements as oppose[d] to command input movements,” from the data acquired by sensor 320, leaving the command input movements. Ex-1017, 8:1-4. These input movements correspond to “input gestures, such as point/drag and button click,” and thus correspond to the claimed “gesture performed by the user.” Ex-1017, 4:38-40; *see also id.*, 7:41-46 (“wearable haptic ring(s)...identify [] gestures”). Thus, filter 322 is configured to identify gestures (in the form of filtered input movements) performed by the user.

g. Element 1[c][iii]: determine that the gesture matches a gesture pattern from a plurality of gesture patterns; and

305. Kruse teaches Element 1[c][iii].

306. As a preliminary matter, as I explained in the Technology Background Section, techniques for gesture recognition would have been well-known to a POSITA in 2013. Such well-known gesture recognition techniques rely on the use of algorithms configured to compare input gestures against pre-determined gesture patterns, the result of which determines how the input gestures are acted upon by the

system. Thus, in 2013, it was well-known that gesture recognition involved “determin[ing] that [a] gesture matches a gesture pattern from a plurality of gesture patterns.”

307. Kruse teaches that filter 322 of Kruse’s device performs the claimed “determin[ation].” In particular, Kruse’s “input identifier,” which is implemented as part of filter 322 (Ex-1017, 2:61-63), is configured to determine that the filtered movement data (“gesture”) matches a gesture pattern from a plurality of gesture patterns.

308. As Kruse explains, the input identifier of filter 322 uses “the filtered movements” (Ex-1017, 2:61-63) “to identify input commands such as mouse button clicks, key strokes, and other selections” (*id.*, 4:14-16). This is done “in accordance with the calibration of [the] wearable remote interface device.” Ex-1017, 10:2-7. A POSITA would have understood that calibrating Kruse’s wearable device “to multiple virtual input devices such as a virtual keyboard and a virtual mouse” (Ex-1017, 10:5-7) would involve generating mappings between input movements that may be detected by the device (e.g., a finger tap) and associated input commands (e.g., a mouse click command). *See* Ex-1017, 8:30-32 (“A user worn wearable haptic ring 102, for example, calibrates and emulates a mouse button click by [the user] tapping his or her finger on a surface 104.”).

309. Then, during normal use, in response to identifying an input movement (“gesture”), the input identifier of filter 322 would determine whether such input movement matches any known movement (“gesture pattern”) of all of the known movements that had been mapped to input commands through the initial calibration process (“a plurality of gesture patterns”).

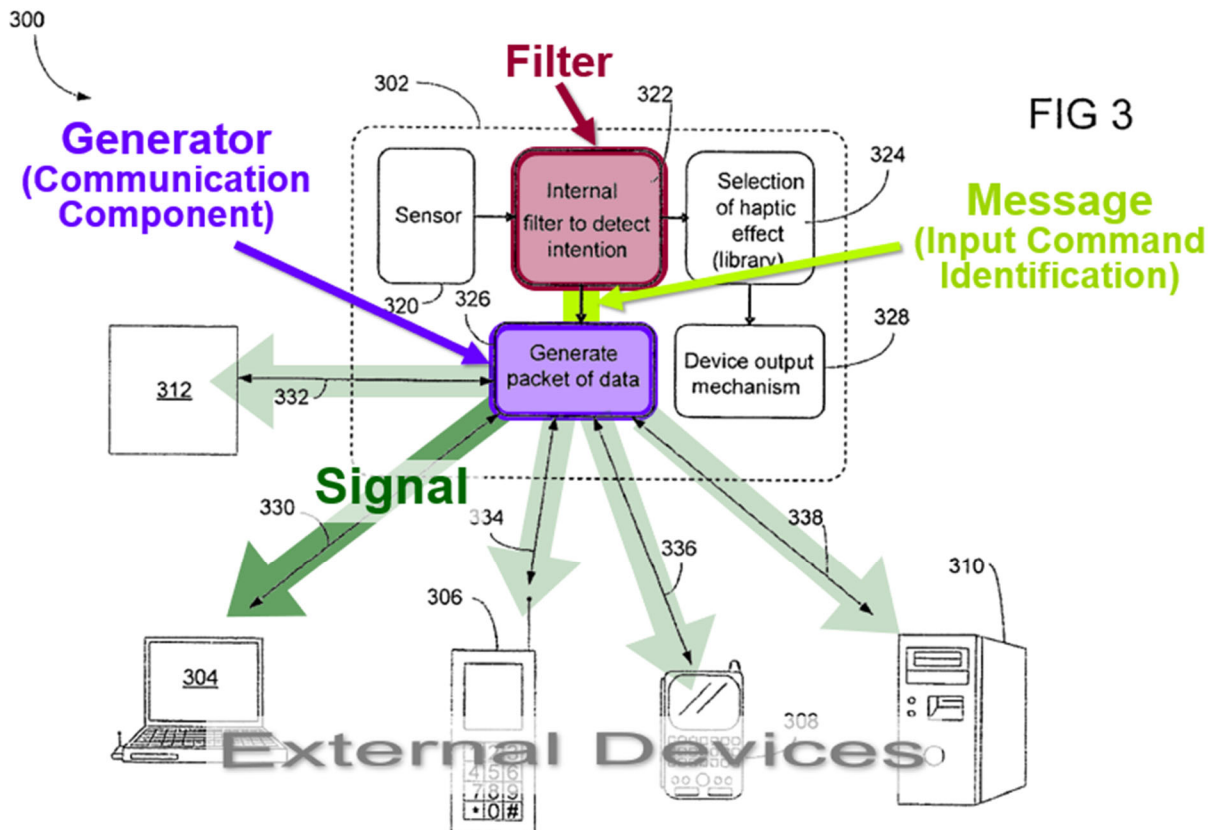
- h. Element 1[c][iv]: generate a message based at least in part on the gesture matching the gesture pattern, wherein the message is configured to cause a feedback component of the wearable electronic device to provide feedback to the user, cause a communication component of the wearable electronic device to transmit a signal to an external device, or both.**

310. Kruse teaches Element 1[c][iv].

311. As explained for Element 1[c][iii], filter 322 matches a user’s input movement (“gesture”) to a known movement (“gesture pattern”), which had been mapped to a particular input command during Kruse’s calibration process. Based on that mapping, filter 322 is then able to identify the particular mapping input command as being the user’s intended input command. In response to identifying that mapped input command, Kruse teaches that wearable device 102/302 is configured both to (1) generate a message configured to cause a feedback component of the device to provide feedback to the user, and (2) generate a message configured to cause a communication component of the device to transmit a signal to an external device. I describe both of these below:

1. Transmit a Signal to an External Device

312. As illustrated in annotated Figure 3, below, in response to identifying the specific input command corresponding to the user's movement of wearable device 102/302, filter 322 is configured to generate and send a message to generator 326, identifying that input command.

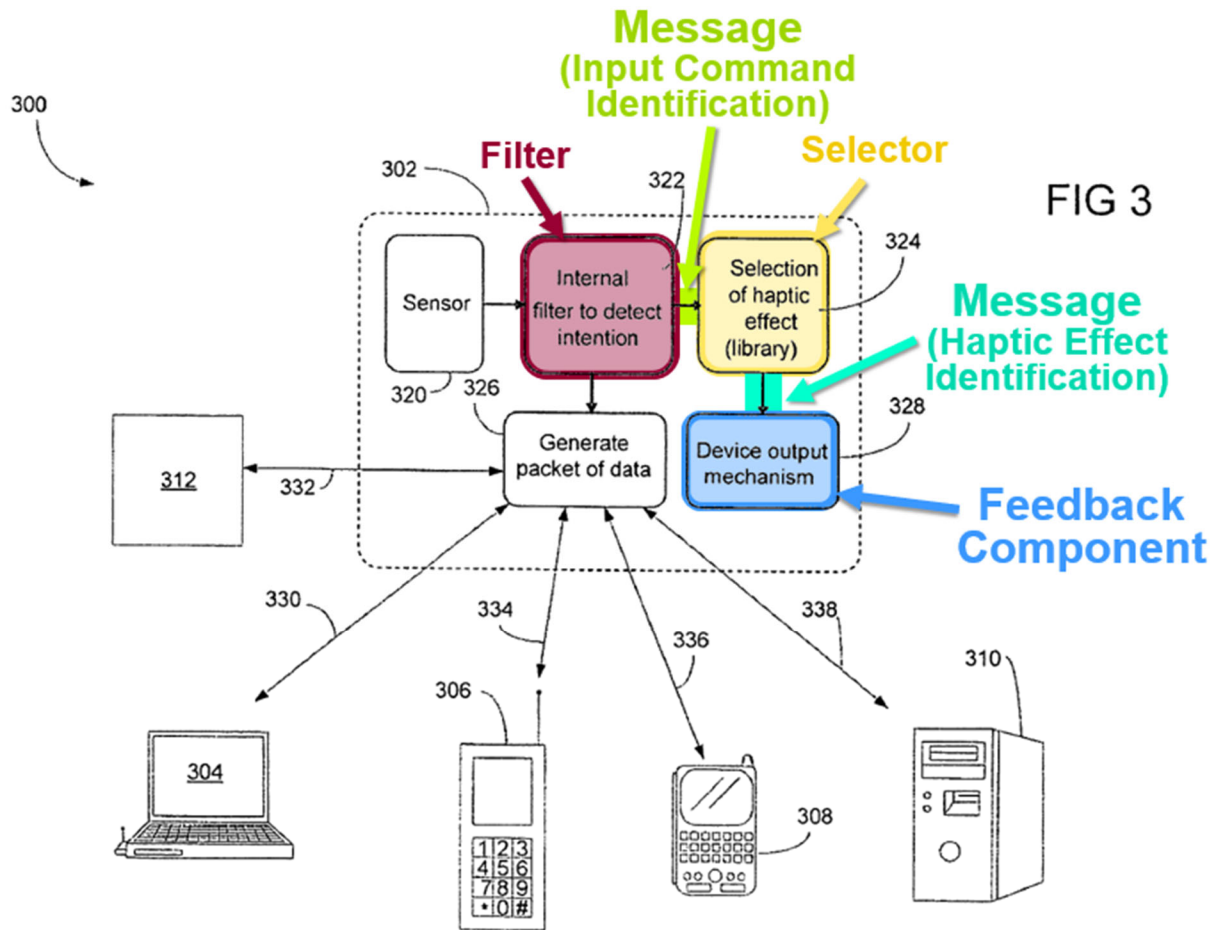


313. In response to receiving the message from filter 322 identifying the input command, generator 326 generates a signal corresponding to that input command, and transmits that input command signal to an external device (e.g., 304) (Ex-1017, 8:6-10) via “a wireless communications network” (e.g., along

communication channel 330) (*id.*, 2:63-64). Generator 326 is thus a “communication component” of Kruse’s wearable device (because it is configured to generate communications that it transmits over communication channels 330-338), and the message sent from filter 322 to generator 300 corresponds to “a message configured to cause a communication component of the device to transmit a signal to an external device.”

2. Provide Feedback to the User

314. As illustrated in annotated Figure 3, below, in response to identifying the specific input command corresponding to the user’s movement of wearable device 102/302, filter 322 is also configured to send a message to selector 324, identifying that input command.



315. As Kruse explains, “selector 324 includes one or more libraries...containing a list of haptic effects.” Ex-1017, 8:12-13. This list of haptic effects “is used to provide haptic feedback to a user,” to confirm the user’s intended input command. Ex-1017, 8:14-15. In particular, each input command “may have a unique confirmation haptic effect,” such that, when activated, not only does it indicate to the user that Kruse’s device registered user movement corresponding to an input command, but it also provides the user with an indication of the specific input command that the device identified. Ex-1017, 8:16-18.

316. In response to receiving the message from filter 322 (which identifies the input command mapped to the filtered user movement (“gesture”)), selector 324 uses its library to identify the haptic effect assigned to the identified input command. *Id.*; *id.*, 4:16-18 (similar). As illustrated in annotated Figure 3, above, in response to identifying the assigned haptic effect, selector 324 sends a message to “[h]aptic output device 328” (“a feedback component”) with “haptic data” corresponding to the assigned haptic effect. Ex-1017, 8:20-21. Haptic output device 328 then “generates feedback in accordance with th[at] haptic data from selector 324.” *Id.* For example, haptic output device 328 may generate “a vibration effect” to confirm a mouse click command. Ex-1017, 8:21-22.

317. A POSITA would have understood that a message can “cause a communication component of the wearable electronic device to transmit a signal to an external device” either by directly instructing the communication component to transmit the signal, or by initiating a process by which the communication component transmits the signal. Thus the message sent from selector 324 to haptic output device 328 corresponds to “a message configured to cause a feedback component of the device to provide feedback to the user” because it causes haptic output device 328 (“a feedback component”) to generate feedback that is provided to the user through wearable device 102/302. And, the message sent from filter 322 to selector 324 also corresponds to the claimed message, because it indirectly causes

haptic output device 328 to generate the feedback for the user, by causing selector 324 to send the message to haptic output device 328. This chain of communication ensures that the user receives the intended feedback through the wearable device. A POSITA would recognize the importance of both direct and indirect messaging in ensuring the proper functioning of the system. The flexibility in messaging pathways allows for robust communication protocols within the device, ensuring that feedback mechanisms are reliably activated regardless of the initial source of the message.

2. Dependent Claims 6-7, and 13-18

a. Claim 6:

- 1. Element 6[a]: The wearable electronic device of claim 1, wherein the plurality of gesture patterns correspond to a plurality of gesture commands,**

318. Kruse teaches Element 6[a].

319. As I explained for Elements 1[c][iii]-1[c][iv], filter 322 of Kruse's wearable device is configured to match filtered movements to known movements of a set of known movements ("a plurality of gesture patterns") established during the initial calibration process, where each of the known movements is mapped to an input command of a set of input commands ("a plurality of gesture commands").

- 2. Element 6[b][i]: wherein the one or more processors are further configured to: identify a gesture command that corresponds to the identified gesture based at least in part on determining that the gesture matches the gesture pattern, the gesture command included within the plurality of gesture commands,**

320. Kruse teaches Element 6[b][i].

321. As I explained for Element 1[c][iii], filter 322 of Kruse's wearable device is configured to match a filtered input movement ("gesture") to a known movement ("gesture pattern") that had been mapped to a specific input command of a set of possible input commands ("the gesture command included within the plurality of gesture commands") during the calibration process. As I explained for Element 1[c][iv], based on this matching, filter 322 is able to identify the particular input command that corresponds to the user's filtered input movement ("identify a gesture command that corresponds to the identified gesture").

- 3. Element 6[b][ii]: wherein the message generated by the one or more processors is configured to perform at least a portion of the gesture command.**

322. As I explained in Section VIII.E, in my opinion, Claim 6 is indefinite because its recitation of a "message...configured to perform...the gesture command" would not have made any sense to a POSITA, and thus fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. However, to the extent this phrase is understood to mean that the message *identifies*

the gesture command, and/or transmission of the message *results in the performance of* the gesture command, Kruse teaches Element 6[b][ii].

323. As I explained for Element 1[c][iv], the message sent from filter 322 to generator 300 corresponds to the claimed “message.” This message includes an identification of the input command (“gesture command”) that was identified as corresponding to the user’s input movement. *See* Element 1[c][iv]. In response to receiving this message, generator 326 transmits an input command signal to an external device (Ex-1017, 8:6-10), where the input command is used to control the external device (*id.*, 4:14-25).

b. Claim 7:

- 1. Element 7[a]: The wearable electronic device of claim 1, wherein the message instructs the communication component to transmit the signal to the external device,**

324. Kruse teaches Element 7[a].

325. As explained for Element 1[c][iv], the message identifying an input command and sent from filter 322 to generator 326 corresponds to the claimed “message,” and the input command signal generated by generator 326 corresponds to the claimed “signal.” In response to receiving the message, generator 326 transmits the input command signal “to one or more processing devices such as PC 304 or PDA 308” (“external devices”). Ex-1017, 8:6-11. Thus, the message instructs generator 326 to transmit the input command signal to the external devices.

2. Element 7[b]: wherein the signal instructs the external device to selectively modify one or more parameters of the external device.

326. Kruse teaches Element 7[b]. The input command signal transmitted by generator 326 is used to control the external device. Ex-1017, 7:46-47. For example, Kruse explains that “wearable haptic ring 102...provides a remote input/output (“I/O”) device to interact with any computers and/or smart objects” and “can be used in place of a computer mouse, a remote control, a keyboard, a phone pad, a touch pad, a touch screen, a touch-screen table computer, etc.” Ex-1017, 4:18-25.

327. Kruse specifically explains that “[w]earable haptic ring 102 is applicable to...an interaction in an automobile, an interaction with any appliance, etc.” Ex-1017, 4:49-51. A POSITA would have recognized that there are a finite number of interactions that a user can have with an appliance. For instance, for an oven, the user can turn on the oven, set the temperature, set a timer, set a cooking mode, turn on/off an internal light, etc. A POSITA would have understood that such interactions involve selectively modifying one or more parameters of the oven (e.g., a temperature parameter, a mode parameter, etc.). In particular, because the temperature and/or operating mode parameter of an oven can take multiple different values, a POSITA would have understood that, by operating to select one of those values, the signal selectively modifies the parameter. A POSITA also would have understood that the selection of, e.g., the temperature corresponds to selectively

modifying a parameter of an external over, because it involves a selection of one parameter (temperature) from multiple other parameters (e.g., operating mode) associated with the oven.

c. Claim 13:

1. Element 13[a]: The wearable electronic device of claim 1, wherein the external device comprises an access node,

328. Kruse teaches Element 13[a].

329. Kruse's wearable device may be used to control external devices such as a server and/or PC (Ex-1017, 7:46-47), and/or a generic processing device (Ex-1017, Figure 3 (processing device 312)). A POSITA would have understood that an "access node" corresponds to a device providing access to a network. For example, according to the IEEE 802.11 standard, an access node, often referred to as an access point, is defined as a device that allows wireless devices to connect to a wired network using Wi-Fi, Bluetooth, or related standards. Accordingly, Kruse's external server and PC correspond to access nodes because they are configured to provide a user with access to a communication network. Ex-1017, 9:20-23 (external computer "may include a modem or a wireless network interface device...that facilitate[s] communication between computer 200 and the network").

2. **Element 13[b]: wherein the communication component is configured to: transmit the signal to the access node, wherein the signal comprises an indication of the gesture based at least in part on the gesture matching the gesture pattern.**

330. Kruse teaches Element 13[b].

331. As explained for Element 1[c][iv], generator 326 transmits an input command signal to control an external device, in response to filter 322 determining that the user's input movement ("gesture") matches a known movement ("gesture pattern") that was mapped to the input command during the calibration process. Thus, the input command signal transmitted by generator 326 "comprises an indication of the gesture" through the stored mapping between the known movement and the input command.

332. Kruse also describes situations in which the input command signal transmitted by generator 326 identifies the gesture performed by the user. Kruse explains that the "specific command gestures" performed by the user "may...mimic natural motions as pointing, dragging, and button clicking" (Ex-1017, 7:41-43), and may be used to control "a touch pad, a touch screen, a touch-screen table computer, etc." (*id.*, 4:22-25). A POSITA would have understood that, when Kruse's wearable device is used as a remote input device for an external touch screen, the specific command gestures performed by the user would mimic the gestures that the user

would otherwise perform directly on the touch screen to control it (but would be performed on some surface other than the touch screen). Accordingly, the input command signals transmitted by Kruse's device to the touch screen would include indications of those command gestures, and would be configured to control the touch screen as if those command gestures had been performed directly on it.

- d. Claim 14: The wearable electronic device of claim 7, wherein the external device comprises a smartphone, a door, an appliance, a keypad, an alarm system, or any combination thereof.**

333. Kruse teaches Claim 14. Kruse's wearable device may be used to control an external device in the form of a smart phone (Ex-1017, 4:26-31), an appliance (*id.*, 4:49-51), and/or a door (*id.*, 5:30-47).

- e. Claim 15: The wearable electronic device of claim 1, wherein the gesture comprises a pointing gesture, a snapping gesture, a tapping gesture, a knocking gesture, a clicking gesture, a swiping gesture, or any combination thereof.**

334. Kruse teaches Claim 15. Kruse explains that the gestures performed by the user while wearing the wearable device "may...mimic natural motions as pointing, dragging, and button clicking." Ex-1017, 7:41-43; *id.*, 4:38-41 (similar).

- f. Claim 16: The wearable electronic device of claim 1, wherein the electronic part comprises an accelerometer, a gyroscope, a magnetometer, a vibration sensor, or any combination thereof.**

335. Kruse teaches Claim 16. As I explained for Element 1[b], Kruse's sensor 320 corresponds to the claimed "electronic part." Sensor 320 corresponds to/includes an "accelerometer." Ex-1017, 3:34-36; *id.*, 8:23-27 (similar).

- g. Claim 17: The wearable electronic device of claim 1, wherein the feedback comprises visual feedback, audio feedback, haptic feedback, or any combination thereof.**

336. Kruse teaches Claim 17. As I explained for Element 1[c][iv], the feedback provided to the user is haptic feedback, generated by "[h]aptic output device 328." Ex-1017, 8:20-22.

- h. Claim 18: The wearable electronic device of claim 1, wherein the wearable electronic device comprises a finger-worn wearable device.**

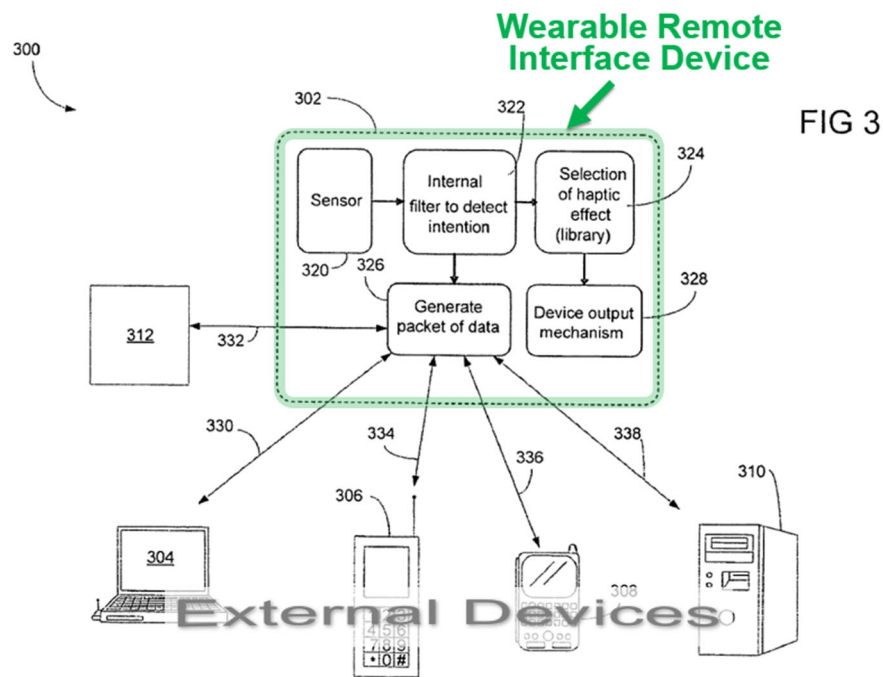
337. Kruse teaches Claim 18. Kruse's wearable remote interface device can "be attached to a finger." Ex-1017, 1:34-35. For instance, Kruse discloses embodiments of the device in the form of a haptic ring (Ex-1017, FIG. 1A), a haptic finger cap (*id.*, FIG. 1B), and a haptic fingernail interface device (*id.*, FIG. 1C).

3. Independent Claim 19:

a. Element 19[pre]: A system for performing gesture recognition, comprising:

338. Kruse teaches the preamble of Claim 19, to the extent it is limiting.

339. Kruse discloses a system including “a wearable remote interface device” 302 and external devices 304-312, as illustrated in annotated Figure 3, below:



340. As I will be discussed for subsequent elements of Claim 19, Kruse’s wearable remote interface device is configured to identify input gestures performed by a user wearing the device, identify commands assigned to those input gestures, and transmit signals to corresponding those commands to control the external devices. Kruse’s system is thus configured for performing gesture recognition.

**b. Element 19[a]: a wearable electronic device
configured to measure acceleration data from a user;**

341. Kruse teaches Element 19[a].

342. As I explained for Element 1[pre], Kruse's wearable device 102 is "wearable" because it can "be attached to a finger or a hand or any parts of a body" (Ex-1017, Abstract; *id.*, 3:8-11 ("[w]earable haptic ring" that "can be worn and/or fit on a finger")), and it is an "electronic device" because it includes a piezoelectric sensor/actuator (*id.*, 3:48-4:2), a wireless transmitter (*id.*, Cl. 1), and internal processing components (*id.*, 9:27-34), all of which a POSITA would have understood to be electronic components. *See, e.g.*, Ex-1017, 1:6-7 (device 102 is an "*electronic* interface device[]").

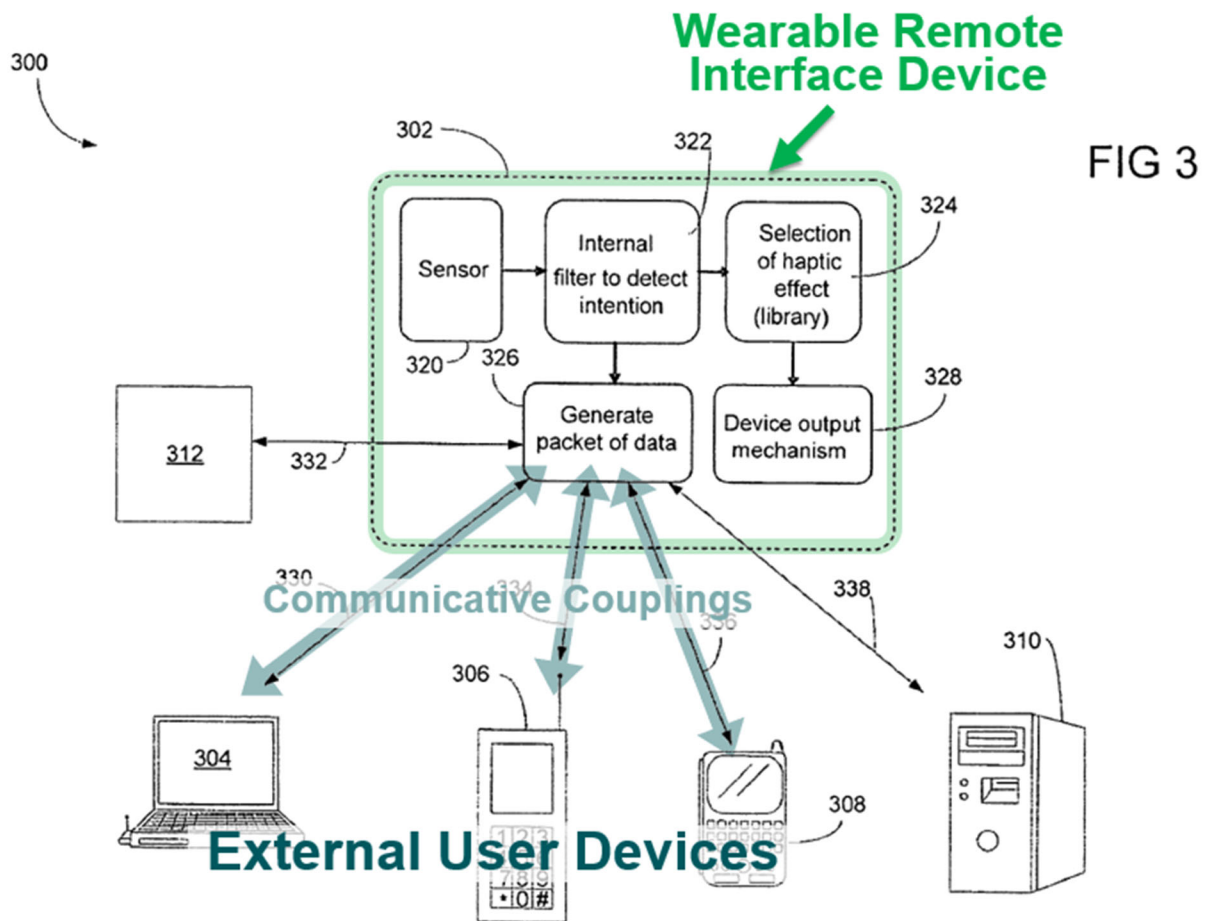
343. As I explained for Element 1[b], device 102 includes an "accelerometer" to sense the motion of a user's finger on which the device is worn. Ex-1017, 3:34-36. A POSITA would have understood that data associated with a user's finger movements and acquired by an accelerometer corresponds to "acceleration data from [the] user."

**c. Element 19[b]: a user device communicatively
coupled to the wearable electronic device, and**

344. Kruse teaches Element 19[b].

345. Kruse discloses user devices in the form of personal computer 304, cellular phone 306, and PDA 308. Ex-1017, 7:55-57. As illustrated in annotated

Figure 3, below, wearable device 302 sends input commands to these external devices “via various communication channels 332-338, which may be wired or wireless communications.” Ex-1017, 8:6-11.



346. Thus, wearable device 302 is communicatively coupled to these user devices.

d. Element 19[c]: one or more processors communicatively coupled with the wearable electronic device and the user device, wherein the one or more processors are configured to:

347. Kruse teaches Element 19[c].

348. As I explained for Element 1[c], Kruse's wearable device includes a processor (Ex-1017, 8:4-6) for executing "computer executable instructions," which correspond to the functional components of the device (*id.*, 9:24-34). When executing the instructions corresponding to filter 322, this processor is communicatively coupled to sensor 320 of device 302, as I explained for Element 1[c]. As I explained for Element 19[b], wearable device 302 is communicatively coupled to external user devices through communication channels 330-338. Thus, the processor of the wearable device is communicatively coupled to those user devices.

e. Element 19[c][i]: receive the acceleration data measured from the user via the wearable electronic device;

349. Kruse teaches Element 19[c][i] for the reasons I explained for Element 1[c][i].

f. Element 19[c][ii]: identify a gesture performed by the user based at least in part on the acceleration data;

350. Kruse teaches Element 19[c][ii] for the reasons I explained for Element 1[c][ii].

- g. Element 19[c][iii]: determine that the gesture matches a gesture pattern from a plurality of gesture patterns; and**

351. Kruse teaches Element 19[c][iii] for the reasons I explained for Element 1[c][iii].

- h. Element 19[c][iv]: generate a message based at least in part on the gesture matching the gesture pattern, wherein the message is configured to cause a feedback component of the wearable electronic device to provide feedback to the user, cause a communication component of the wearable electronic device or the user device to transmit a signal to an external device, or both.**

352. Kruse teaches Element 19[c][iv].

353. Kruse teaches that the processor of wearable device 102/302 is configured to “generate a message based at least in part on the gesture matching the gesture pattern, wherein the message is configured to cause a feedback component of the wearable electronic device to provide feedback to the user,” for the reasons explained for Element 1[c][iv].

4. Dependent Claim 20:

- a. Claim 20: The system of claim 19, wherein the one or more processors are positioned within the wearable electronic device, within the user device, within one or more external servers, or any combination thereof.**

354. Kruse teaches Claim 20. As I explained for Element 19[c], Kruse teaches a processor within wearable device 102.

D. Ground 4: Claims 2-5, and 13 Are Obvious Over Kruse In View Of Sun

1. A POSITA would have been motivated to combine Sun and Kruse and would have had a reasonable expectation of success

355. A POSITA would have been motivated to combine Sun and Kruse and would have had a reasonable expectation of success, for the reasons I explained in Section VIII.B.1, as well as the additional reasons I provide below.

356. Kruse's haptic device includes filter 322 to "filter extraneous gestures or motions" from a sensed input motion, where "the extraneous gesture or extraneous motion is related to the nature of hand movement." Ex-1017, 9:60-66. A POSITA seeking to implement Kruse's haptic device would have been motivated to search for additional references providing implementation details that may be used for filtering out extraneous motions that do not correspond to gesture commands. *Id.* Sun is one such reference.

357. Sun teaches that gestures may be distinguished from extraneous motion, through the use of velocity and/or acceleration thresholds. Ex-1015, ¶42. In particular, Sun discloses that detected movements may correspond to gestures when the movements "exceed[] one or both of a threshold velocity or a threshold acceleration." *Id.* A POSITA seeking to implement Kruse's filter 322 to remove extraneous motions from actual gestures, would have been motivated to use Sun's

velocity/acceleration thresholds to do so, as they correspond to easy-to-implement rules for performing such filtering.

358. As another motivation to combine Kruse and Sun, Kruse explains that an initial “calibration” process is used to configure Kruse’s haptic ring to identify the “input commands” assigned to filtered movements that are sensed by the ring. Ex-1017, 10:1-7. A POSITA seeking to implement Kruse’s haptic ring would have been motivated to search for additional references providing implementation details that may be used for calibrating the ring to identify user movements as corresponding to particular input commands.

359. Sun teaches a training mode that may be used to enable Sun’s wrist/finger mouse to identify new command gestures that are assigned by the user to new commands for controlling external computer 18. Ex-1015, ¶33. In Sun’s training mode, the user uses computer 18 to specify a new input command, to which a new gesture should be mapped. *Id.* The user then performs the new gesture multiple times, resulting in the generation of “a composite new command gesture,” which is “added to the library of command gestures” stored on wrist/finger mouse 14. *Id.*

360. A POSITA would have understood that Sun’s training mode could be used to implement Kruse’s calibration process, through which Kruse’s haptic ring is calibrated to identify user movements corresponding to specific input commands.

Accordingly, a POSITA would have been motivated to turn to Sun for implementation details. Such a POSITA would have had a reasonable expectation of success in using Sun's training mode to calibrate Kruse's haptic ring. As I explained in Section VIII.B.1, a POSITA would have understood that filter 322 of Kruse's haptic ring would store mappings between input movements that may be detected by the device (e.g., a finger tap) and associated input commands (e.g., a mouse click command). *See* Ex-1017, 8:30-32. Thus, implementing Sun's training mode in Kruse's system would involve generating new entries in the mappings stored in Kruse's device, in the same manner as Sun teaches for generating new entries in Sun's Command Motion Library.

2. Claim 2:

- a. Element 2[a]: The wearable electronic device of claim 1, wherein the one or more processors are further configured to: determining that a portion of the acceleration data satisfies an acceleration threshold,**

361. Kruse-Sun teaches Element 2[a].

362. As I explained in Section VIII.D.1, a POSITA would have been motivated to implement Sun's acceleration threshold within Kruse's filter 322, to remove "extraneous gestures or motions from the input motion" sensed by sensor 320, leaving input motion that satisfies the acceleration threshold. Ex-1017, 9:60-66.

- b. Element 2[b]: wherein identifying the gesture performed by the user is based at least in part on the portion of the acceleration data satisfying the acceleration threshold.**

363. Kruse-Sun teaches Element 2[b].

364. As I explained in Section VIII.C.1.f (Ground 3, Element 1[c][ii]), filter 322 is configured to identify gestures performed by the user, by filtering “extraneous gesture or extraneous motion” from input motion sensed by sensor 320. As I explained above, in the combined Kruse-Sun system, filter 322 performs such filtering by removing motion for which the acceleration does not satisfy Sun’s acceleration threshold.

3. Claim 3:

- a. Element 3[a]: The wearable electronic device of claim 1, wherein the one or more processors are further configured to: receive an indication of a training mode for gesture recognition;**

365. Kruse-Sun teaches Element 3[a].

366. As I explained in Section VIII.D.1 (motivation to combine Kruse and Sun), a POSITA would have been motivated to implement Sun’s training mode for the purpose of calibrating Kruse’s haptic ring. Sun teaches receiving an indication of a training mode, for the reasons explained in Section VIII.A.2.b.1 (Ground 1, Element 3[a]).

- b. Element 3[b]: receiving additional acceleration data from the electronic part based at least in part on receiving the indication of the training mode; and**

367. Sun-Kruse teaches Element 3[b], for the reasons I explained in Section VIII.A.2.b.2 (Ground 1, Element 3[b]).

- c. Element 3[c]: generating the gesture pattern included within the plurality of gesture patterns based at least in part on the additional acceleration data.**

368. Sun-Kruse teaches Element 3[c], for the reasons I explained in Section VIII.A.2.b.3 (Ground 1, Element 3[c]).

4. Claim 4:

- a. Element 4[a]: The wearable electronic device of claim 3, wherein the one or more processors are further configured to: receive a user input comprising a gesture command that is to be performed at least in part by the wearable electronic device upon identifying the gesture that matches the gesture pattern,**

369. Sun-Kruse teaches Element 4[a], for the reasons I explained in Section VIII.A.2.c.1 (Ground 2, Element 4[a]).

- b. Element 4[b]: wherein generating the message is based at least in part on receiving the user input.**

370. Sun-Kruse teaches Element 4[b], for the reasons I explained in Section VIII.A.2.c.2 (Ground 2, Element 4[b]).

5. Claim 5:

- a. Element 5[a]: The wearable electronic device of claim 3, wherein the additional acceleration data is associated with multiple instances of a training gesture performed by the user, the training gesture associated with the gesture, wherein generating the gesture pattern is based at least in part on the multiple instances of the training gesture, wherein the one or more processors are further configured to:**

371. Sun-Kruse teaches Element 5[a], for the reasons I explained in Section VIII.A.2.d.1 (Ground 1, Element 5[a]).

- b. Element 5[b]: generate one or more error tolerances associated with the gesture pattern based at least in part on the multiple instances of the training gesture, wherein determining that the gesture matches the gesture pattern is based at least in part on the one or more error tolerances.**

372. Sun-Kruse teaches Element 5[b], for the reasons I explained in Section VIII.A.2.d.2 (Ground 1, Element 5[b]).

- 6. Claim 11: The wearable electronic device of claim 1, wherein the one or more processors are configured to: authenticate an identity of the user based at least in part on determining that the gesture matches the gesture pattern, wherein generating the message is based at least in part on authenticating the identity of the user.**

373. Kruse-Sun teaches Claim 11.

374. As I explained in Section VIII.A.2.g (Ground 1, Element 11[a]), Sun teaches configuring Sun's wrist/finger mouse and external computer 18 such that a sequence of tap gestures "can be used to enter a password to, for example, allow

access to computer 18.” Ex-1015, ¶38. Here, the wrist/finger mouse would generate input signal 28 (“the message”) and command signal 16 (instructing computer 18 to allow access to the user), in response to determining that the sequence of tap gestures performed by the user matches a predefined sequence stored in the library (i.e., “authenticating the identity of the user” based on the gesture password entered by the user). Ex-1015, ¶44.

375. Kruse similarly teaches that the wearable device may be used for authentication purposes. Specifically, Kruse teaches that the wearable device may be used to enter “a secret code for authentication,” by using haptic feedback from the device to locate a virtual keyboard, and then entering the secret code using the virtual keyboard. Ex-1017, 5:30-47. This method leverages the device’s ability to provide tactile feedback to guide the user in interacting with a virtual interface for secure authentication. Based on this disclosure, a POSITA seeking to implement Kruse’s wearable device would have been motivated to search for additional ways in which Kruse’s wearable device could be used for user-authentication purposes, such as that taught by Sun. Such a POSITA would have recognized that Sun’s authentication method could be implemented to improve Kruse’s authentication process, by removing the need for the user to search around on the surface of a door that the user seeks to unlock in order to locate a virtual keypad. Instead, the user could simply perform a sequence of gestures corresponding to a passcode stored by

both the wearable device and electronics controlling the door, and wirelessly transmit the passcode to the door to open it, following local authentication of the passcode by the wearable device. By integrating Sun's gesture-based authentication method, the wearable device would enable a more seamless and intuitive user experience. Upon performing the correct sequence of gestures, the device would locally authenticate the passcode and wirelessly communicate with the door's electronic locking mechanism to grant access. This method not only simplifies the authentication process but also enhances security by reducing the chances of unauthorized access through physical tampering or observation. The gesture-based approach offers greater flexibility and convenience for users. It allows for authentication in various scenarios where locating a virtual keyboard might be impractical or time-consuming. For example, in low-light conditions or situations where the user's hands are occupied, performing gestures would be quicker and more efficient than interacting with a virtual keypad.

E. Ground 5: Claim 6 Is Invalid Under 35 U.S.C. §112 As Indefinite

376. As explained to me by counsel, I understand that a claim is invalid for indefiniteness if, when read in light of the specification delineating the patent and the prosecution history, it fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention. As explained below, in my opinion, Claim 6's recited limitation of "the message generated by the one or more processors is

configured to perform at least a portion of the gesture command” fails to inform, with reasonable certainty, those skilled in the art about the scope of the invention, because this limitation would not have made any sense to a POSITA.

377. Claim 6 of the ’701 Patent recites:

[Element 6[a]] The wearable electronic device of claim 1, wherein the plurality of gesture patterns correspond to a plurality of gesture commands, wherein the one or more processors are further configured to:

[Element 6[b][i]] identify a gesture command that corresponds to the identified gesture based at least in part on determining that the gesture matches the gesture pattern, the gesture command included within the plurality of gesture commands,

[Element 6[b][ii]] wherein *the message* generated by the one or more processors *is configured to perform at least a portion of the gesture command.*

378. As illustrated above, Element 6[b][ii] recites “wherein *the message* generated by the one or more processors *is configured to perform* at least a portion of *the gesture command.*” A POSITA would not have known how a “message” itself could *perform* a command. In particular, a POSITA would have understood that a message itself can only provide information, not processing capabilities. Accordingly, while a message could provide instructions to a computer component capable of processing, instructing that component to perform a command, the message, itself, is not capable of performing the command. For example, the message could include instructions directing the processing component to execute a software component that, when executed performs the command. Or, the message

could include an executable for execution by the processing component upon receipt, that, when executed, performs the command. But *some other processing component* must actually perform the command.

379. Thus, as written, Element 6[b][ii] prevents a POSITA from understanding what is being claimed with reasonable certainty, because it is nonsensical and requires an impossibility—that information alone (as opposed to, for example, a processor executing instructions contained within that information) can *perform* a command.

380. For at least these reasons, Claim 6 is invalid for indefiniteness.

IX. CONCLUSION

381. For the reasons set forth above, I believe that Claims 1-7, 11, and 13-20 of the '701 Patent are unpatentable in view of the prior art.

382. In signing this declaration, I recognize that it 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 in 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.

383. 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.

384. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Dated: June 28, 2024

Respectfully Submitted,

A handwritten signature in blue ink, appearing to read "Brian W. Anthony", is written over a horizontal line.

Brian W. Anthony, Ph.D.