IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	BOSHERNITZAN et al.	
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Title:	SYSTEM AND METHOD FOR CONTROLLING A TERMINAL DEVICE	

DECLARATION OF DR. BENJAMIN B. BEDERSON

I declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Dated: September 29, 2024

By: 

Dr. Benjamin B. Bederson

Table of Contents

I. INTRODUCTION AND SCOPE OF WORK 1

II. QUALIFICATIONS 2

III. MATERIALS CONSIDERED 9

IV. SUMMARY OF CONCLUSIONS 19

V. LEGAL PRINCIPLES 20
- A. Person of Ordinary Skill in the Art 20
- B. Obviousness 20
- C. Claim Construction Standard 22

VI. PERSON OF ORDINARY SKILL IN THE ART 23
- A. A POSITA's Ordinary Level of Skill 23
- B. A POSITA's Backgrounds Knowledge 24
  1. Background of the Technology 24
  2. Devices for Performing Actions Based on Sensed Data 26
  3. Accelerometer Basics 29

VII. OVERVIEW OF THE '738 PATENT 31
- A. Overview of the '738 Patent 31
- B. Summary of Prosecution History of the '738 Patent 36

VIII. INTERPRETATIONS OF THE '738 PATENT CLAIMS AT ISSUE 37
- A. "engagement means…" 43
- B. "said contact interaction being comprised of an impact on said mounting surface" 48
- C. "routing module … said routing module receiving said data signals from said sensor" 51
- D. "processing module … said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile" 53
- E. "output module … said output module transmitting said command to said receiving module" 56
- F. "terminal device" 57
- G. "receiving module" 60
- H. "means for initiating activity of said terminal device corresponding to said command" 61

IX. APPLICATION OF PRIOR ART TO THE CHALLENGED CLAIMS.....63
A. GROUND 1A: THE MURAKOSHI-STEWART COMBINATION RENDERS CLAIMS 1-2, 4-5, AND 8-10 OBVIOUS.....68
1. Overview of Murakoshi (APPLE-1004).....68
2. Overview of Stewart (APPLE-1006).....71
3. The Murakoshi-Stewart Combination.....73
a) The Combination.....73
b) Reasons for the Combination.....76
4. Element-by-Element Analysis.....84
c) Claim 1.....84
[1pre] A control system comprising:.....84
[1a] a housing having an engagement means for a mounting surface;.....86
[1b-i] a sensor contained within said housing,.....89
[1b-ii] said sensor forming an interactive zone defined by a range of said sensor,.....90
[1b-iii] said sensor being comprised of an accelerometer,.....91
[1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing,.....92
[1b-v] said sensor being in a fixed position relative to said engagement means,.....94
[1b-vi] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals,.....95
[1b-vii] said contact interaction being comprised of an impact on said mounting surface,.....96
[1b-viii] said data signals being comprised of vibration data of said contact interaction;.....97
[1c-i] a server in communication with said sensor,.....98
[1c-ii] said server being comprised of a routing module,.....100
[1c-iii] a processing module being connected to said routing module, and.....100
[1c-iv] an output module connected to said processing module,..101

[1c-v] said routing module receiving said data signals from said sensor,.....102

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and.....103

[1d-i] a terminal device.....106

[1d-ii] being comprised of a receiving module 107

[1d-iii] and means for initiating activity of said terminal device corresponding to said command,.....108

[1d-iv] said terminal device being in communication with said server, ...110

[1d-v] said output module transmitting said command to said receiving module, ...111

[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion. 112

d) Claim 2 120

[2] The control system, according to claim 1, wherein said interactive zone of said sensor aligns with said mounting surface, said interactive zone being coplanar with said mounting surface. 120

e) Claim 8 122

[8] The control system, according to claim 1, wherein said terminal device is comprised of one device selected from a group consisting of: a television, a thermostat, a computer, a software system, a game console, a fan, a mattress adjustor, an alarm clock, and a lighting fixture. 122

f) Claim 9 123

[9] The control system, according to claim 1, further comprising: an additional terminal device being comprised of an additional receiving module and additional means for initiating activity of said additional terminal device corresponding to an additional command, said additional terminal device being in communication with said server, said output

module transmitting said additional command to said additional receiving module. 123
g) Claim 10 125
[10pre]-[10k-i] 129
[10k-ii] said command corresponding to activity of said terminal device; and....131
[10l] performing said activity with said terminal device. 131
B. GROUND 1B: THE MURAKOSHI-STEWART-SACHS COMBINATION RENDERS CLAIMS 1-2, 4-5, AND 8-11 OBVIOUS 132
1. Sachs....132
2. Murakoshi-Stewart-Sachs Combination 137
a) The Combination....137
b) Reasons for the Combination 139
3. Element-by-Element Analysis....148
a) Claim 1 148
[1pre]-[1c-v], [1d-i]-[1e]....148
[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and....149
b) Claims 2, 8-9 151
c) Claim 4 151
[4a] The control system, according to claim 1, wherein said contact interaction is comprised of an impact on said mounting surface,....151
[4b] said data signals having a respective defined peak corresponding to each impact, a defined time period after a last defined peak, [4c] said data pattern being comprised of each defined peak and said defined time period after said last defined peak. 153
d) Claim 5 155
[5a] The control system, according to claim 1, wherein said contact interaction is comprised of a plurality of impacts on said mounting surface, ...155
[5b] said data signals having a respective defined peak corresponding to each impact, a measured time period between each

defined peak, and a defined time period after a last defined peak, said data pattern being comprised of each defined peak, each measured time period, and said defined time period after said last defined peak. 157

e) Claim 10 158

[10pre]-[10l].....158

f) Claim 11 159

[11] The method of controlling the terminal device, according to claim 10, wherein the step of making a physical impact on said mounting surface further comprises making a plurality of physical impacts on said mounting surface, said contact interaction being associated with more than one physical impact.....159

C. GROUND 1C: THE MURAKOSHI-STEWART-SACHS-ORR COMBINATION RENDERS CLAIMS 1-2, 4-5, AND 8-11 OBVIOUS 160

1. Orr.....160

2. The Combination of Murakoshi-Stewart-Sachs and Orr 162

a) The Combination.....162

b) Reasons for the Combination 165

3. Element-by-Element Analysis.....173

a) Claim 1 173

[1pre] A control system comprising: 173

[1a] a housing having an engagement means for a mounting surface; 173

[1b-i] a sensor contained within said housing, ...178

[1b-ii] said sensor forming an interactive zone defined by a range of said sensor, ...179

[1b-iii] said sensor being comprised of an accelerometer, ...180

[1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing, ...180

[1b-v] said sensor being in a fixed position relative to said engagement means, ...181

[1b-vi] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals,.....182

[1b-vii] said contact interaction being comprised of an impact on said mounting surface, ...183

[1b-viii] said data signals being comprised of vibration data of said contact interaction; 184

[1c-i] a server in communication with said sensor, ...185

[1c-ii] said server being comprised of a routing module, ...187

[1c-iii] a processing module being connected to said routing module, and 188

[1c-iv] an output module connected to said processing module, ..189

[1c-v] said routing module receiving said data signals from said sensor, ...190

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and 194

[1d-i] a terminal device 198

[1d-ii] being comprised of a receiving module 199

[1d-iii] and means for initiating activity of said terminal device corresponding to said command, ...200

[1d-iv] said terminal device being in communication with said server, ...201

[1d-v] said output module transmitting said command to said receiving module, ...203

[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion. 206

b) Claim 10 214

[10pre]-[10c], [10e-ii]-[10g], [10k-ii]-[10l] 214

[10k-ii]-[10l] 214

c) Claims 2, 8-9 215

d) Claims 4, 5, 11 215
D. GROUND 2A: THE LI-IFIXIT COMBINATION RENDERS CLAIMS 1-2 AND 9-10 OBVIOUS.....216
1. Li.....216
2. iFixit 220
a) iFixit Report is a prior art printed publication 220
(i) The iFixit Report published September 2014.....221
(ii) A POSITA would have been familiar with iFixit and the iFixit Report.....222
(iii)..... A POSITA would have been able to locate the iFixit Report because it was indexed 224
b) iFixit Teardown Report 227
3. Li-iFixit Combination 228
a) The Combination.....228
b) Reasons for the Combination 234
4. Element-by-Element Analysis.....241
a) Claim 1 241
[1pre] A control system comprising: 241
[1a] a housing having an engagement means for a mounting surface; 242
[1b-i] a sensor contained within said housing, ...248
[1b-ii] said sensor forming an interactive zone defined by a range of said sensor, ...249
[1b-iii] said sensor being comprised of an accelerometer, ...251
[1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing, ...252
[1b-v] said sensor being in a fixed position relative to said engagement means, ...254
[1b-vi] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals,.....256
[1b-vii] said contact interaction being comprised of an impact on said mounting surface, ...258

[1b-viii] said data signals being comprised of vibration data of said contact interaction; 260

[1c-i] a server in communication with said sensor, ...260

[1c-ii] said server being comprised of a routing module, ...261

[1c-iii] a processing module being connected to said routing module, and 262

[1c-iv] an output module connected to said processing module, ..263

[1c-v] said routing module receiving said data signals from said sensor, ...265

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and 266

[1d-i] a terminal device 267

[1d-ii] being comprised of a receiving module 269

[1d-iii] and means for initiating activity of said terminal device corresponding to said command, ...271

[1d-iv] said terminal device being in communication with said server, ...272

[1d-v] said output module transmitting said command to said receiving module, ...273

[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion. 274

b) Claim 2 283

[2] The control system, according to claim 1, wherein said interactive zone of said sensor aligns with said mounting surface, said interactive zone being coplanar with said mounting surface. 283

c) Claim 8……284

[8] The control system, according to claim 1, wherein said terminal device is comprised of one device selected from a group consisting of: a television, a thermostat, a computer, a software system, a game console, a fan, a mattress adjustor, an alarm clock, and a lighting fixture.
d) Claim 9 284
[9] The control system, according to claim 1, further comprising: an additional terminal device being comprised of an additional receiving module and additional means for initiating activity of said additional terminal device corresponding to an additional command, said additional terminal device being in communication with said server, said output module transmitting said additional command to said additional receiving module. 286
d) Claim 10 288
[10pre]-[10k-i] 288
[10k-ii] said command corresponding to activity of said terminal device; and.....288
[10l] performing said activity with said terminal device. 291
E. GROUND 2B: THE LI-iFIXIT-SACHS COMBINATION RENDERS CLAIMS 4-5 AND 11 OBVIOUS 291
1. Li-iFixit-Sachs Combination 291
a) The Combination 291
b) Reasons for the Combination 296
c) Claim 4 304
[4a] The control system, according to claim 1, wherein said contact interaction is comprised of an impact on said mounting surface,.....304
[4b] said data signals having a respective defined peak corresponding to each impact, a defined time period after a last defined peak, said data pattern being comprised of each defined peak and said defined time period after said last defined peak. 305
d) Claim 5 307
[5a] The control system, according to claim 1, wherein said contact interaction is comprised of a plurality of impacts on said mounting surface, ...307
[5b] said data signals having a respective defined peak corresponding to each impact, a measured time period between each defined peak, and a defined time period after a last defined peak, said data

pattern being comprised of each defined peak, each measured time period, and said defined time period after said last defined peak. 308

e) Claim 11 310

[11] The method of controlling the terminal device, according to claim 10, wherein the step of making a physical impact on said mounting surface further comprises making a plurality of physical impacts on said mounting surface, said contact interaction being associated with more than one physical impact.....310

I, Dr. Benjamin B. Bederson Ph.D., of College Park, Maryland, declare that:

I. INTRODUCTION AND SCOPE OF WORK

1. I have been retained by Fish & Richardson P.C., on behalf of Apple ("Petitioner"), as an independent expert consultant in this *inter partes* review ("IPR") proceeding before the United States Patent and Trademark Office.

2. I have been asked by Petitioner's counsel ("Counsel") to consider whether certain references teach or suggest the features recited in Claims 1, 2, 4, 5, and 8-11 of U.S. Patent No. 9,996,738 ("the 738 patent") (APPLE-1001). My opinions and the bases for my opinions are set forth below. My opinions are based on my education and experience.

3. In writing this Declaration, I have considered the following: the prior art publications cited below and my own knowledge and experience, including my teaching and work experience in the below-described fields, and my experience of working with others in those fields during the relevant period.

4. I have no financial interest in either party or in the outcome of this proceeding. I am being compensated for my work on an hourly basis for all tasks involved and am being compensated at my standard consulting rate of $600 per hour for my services. My compensation is not dependent on the outcome of these proceedings or on any pending litigation, and my compensation is also not

dependent on the content of my opinions. I have no direct financial interest in any of the parties associated with this matter.

II. QUALIFICATIONS

5. My *curriculum vitae*, which includes a more detailed summary of my background, experience, and publications, is attached as APPENDIX-A.

6. I received a Bachelor of Science degree in Computer Science with a minor in Electrical Engineering from Rensselaer Polytechnic Institute ("RPI") in 1986. I received a Master of Science degree and a Ph.D. in Computer Science from New York University ("NYU") in 1989 and 1992, respectively.

7. Since 1998, I have been a Professor of Computer Science at the University of Maryland ("UMD"), where I have had joint appointments at the Institute for Advanced Computer Studies and the College of Information Studies (Maryland's "iSchool") and am currently Professor Emeritus. I was also Associate Provost of Learning Initiatives and Executive Director of the Teaching and Learning Transformation Center from 2014 to 2018. I am a member and previous director of the Human-Computer Interaction Lab ("HCIL"), the oldest and one of the best known Human-Computer Interaction research groups in the country.

8. I am also co-founder and co-director of the International Children's Digital Library ("ICDL"), a web site launched in 2002 that provides the world's largest collection of freely available online children's books from around the world

with an interface aimed to make it easy for children and adults to search and read children's books online. I was also co-founder and Chief Scientist of Zumobi, Inc. from 2006 to 2014, a Seattle-based startup that is a publisher of content applications and advertising platforms for smartphones. I was also co-founder and prior Chief Technology Officer of Hazel Analytics, a data analytics company whose product sends alerts in warranted circumstances. In addition, I have for more than 25 years consulted for numerous companies in the area of user interfaces, including Logitech, Microsoft, the Palo Alto Research Center, Sony, Lockheed Martin, and NASA Goddard Space Flight Center.

9. For more than 30 years, I have studied, designed, and worked in the field of computer science and human-computer interaction. My experience includes 30 years of teaching and research, with research interests in human-computer interaction and the software and technology underlying today's interactive computing systems. This includes the design and implementation of user interfaces and software applications using a wide range of technologies including web servers and websites, databases, embedded systems, and mobile devices, including smart phones and PDAs. I have combined my hardware and software skills throughout my career in Human-Computer Interface research, building various interactive electrical and mechanical systems that couple with software to provide an innovative user experience.

10. At UMD, my research has been in the area of Human-Computer Interaction ("HCI"), a field that relates to the development and understanding of computing systems to serve users' needs. Researchers in this field are focused on making universally usable, useful, efficient, and appealing systems to support people in their wide range of activities. My approach is to balance the development of innovative technology that serves people's practical needs. Example systems following this approach that I have built include Pad++ (1994 software for zoomable user interfaces), KidPad (1997 software to support children collaboratively writing stories), PadPrints (1998 software to graphically show interactive web browsing histories), PhotoMesa (2001 software for end users to browse personal photos), Pocket PhotoMesa (2004 software for browsing of personal photos on a mobile device), DateLens (2002 software for end users to use their mobile devices to efficiently access their calendar information), LaunchTile (2005 "home screen" software for mobile devices to allow users to navigate apps in a zoomable environment), SpaceTree (2001 software for end users to efficiently browse very large hierarchies), ICDL (as described above), and StoryKit (a 2009 iPhone app for children to create stories).

11. Many of my projects involved processing user inputs and interpreting them to determine what command they controlled. For example, in 2001 I wrote a

paper[1] that describes PhotoMesa, a zoomable image browser using a novel 2D layout algorithm I called "quantum treemaps" to position the images on the screen in a way that attempted to fill the screen while keeping groups of related images together. As indicated in the figure below, PhotoMesa had a number of interactions that controlled the display of many hundreds of images at a time. Users could zoom in and out, pan from side to side, and show larger thumbnails through a combination of mouse clicks, drags, and hovers.

[1] Benjamin B. Bederson, *PhotoMesa: A Zoomable Image Browser Using Quantum Treemaps and Bubblemaps*, UIST '01: PROCEEDINGS OF THE 14TH ANNUAL ACM SYMPOSIUM ON USER INTERFACE SOFTWARE AND TECHNOLOGY, Nov. 2001, at 71–80, https://doi.org/10.1145/502348.502359.



Figure 1: Screen snapshot of PhotoMesa with over 500 images in 17 groups.

12. Another example was in software I wrote in 2004-2005 called LaunchTile which included a Graphical User Interface for touch screen mobile devices designed for one handed use. LaunchTile, described in a 2005 paper[2], allowed zooming and scrolling of multiple applications on a handheld touchscreen PDA. The interface offered a grid of applications that could be zoomed and

[2] Amy K. Karlson, Benjamin B. Bederson, and John SanGiovanni. 2005. AppLens and launchTile: two designs for one-handed thumb use on small devices. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '05). Association for Computing Machinery, New York, NY, USA, 201–210. https://doi.org/10.1145/1054972.1055001

scrolled. It included several different methods of navigating, including gestures as shown in the following figure from that paper where scrolling continued after a finger was lifted from the touch screen, and then slowed to a stop.



Figure 2. Screen area accessible with one hand.

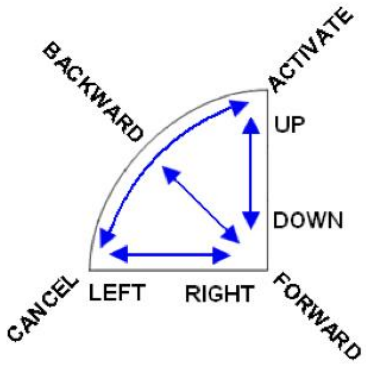


Figure 3. The gesture set.

13. My work has been published extensively in more than 160 technical publications, and I have given about 100 invited talks, including 9 keynote lectures. I have won a number of awards including the Janet Fabri Memorial Award for Outstanding Doctoral Dissertation for my Ph.D. work in robotics and computer vision as well as the Brian Shackel Award for "outstanding contribution with international impact in the field of HCI" in 2007, and the Social Impact Award in 2010 from Association for Computing Machinery's ("ACM") Special Interest Group on Computer Human Interaction ("SIGCHI"). ACM is the primary international professional community of computer scientists, and SIGCHI is the primary international professional HCI community. I have been honored by both professional organizations. I am an "ACM Distinguished Scientist," which

"recognizes those ACM members with at least 15 years of professional experience and 5 years of continuous Professional Membership who have achieved significant accomplishments or have made a significant impact on the computing field." I am a member of the "CHI Academy," which is described as follows: "The CHI Academy is an honorary group of individuals who have made substantial contributions to the field of human-computer interaction. These are the principal leaders of the field, whose efforts have shaped the disciplines and/or industry, and led the research and/or innovation in human-computer interaction." The criteria for election to the CHI Academy are: (1) cumulative contributions to the field; (2) impact on the field through development of new research directions and/or innovations; and (3) influence on the work of others. I have received two "Test of Time" awards from IEEE InfoVis for my 2001 and 2002 work on visualizing hierarchies, including those containing digital photos.[3]

14. I have appeared on radio shows numerous times to discuss issues relating to user interface design and people's use and frustration with common technologies, web sites, and mobile devices. My work has been discussed and I have been quoted by mainstream media around the world over 120 times, including

[3] https://ieeevis.org/year/2021/info/awards/test-of-time-awards; https://ieeevis.org/year/2022/info/awards/test-of-time-awards.

by the NEW YORK TIMES, the WALL STREET JOURNAL, the WASHINGTON POST, NEWSWEEK, the SEATTLE POST-INTELLIGENCER, the INDEPENDENT, LE MONDE, NPR's *All Things Considered*, NEW SCIENTIST MAGAZINE, and MIT's TECHNOLOGY REVIEW.

15. I have designed, programmed, and publicly deployed dozens of user-facing software products that have cumulatively had millions of users. I am the co-inventor of 14 U.S. patents and 20 U.S. patent applications.

III. MATERIALS CONSIDERED

16. I have reviewed the '738 patent (APPLE-1001) and relevant excerpts of its prosecution history (APPLE-1002). For purposes of this Declaration, I am using February 13, 2013 as the Critical Date.

17. As part of my independent analysis for this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of computer-user interactions and interfaces; my experience in teaching those subjects; and my experience in working with others involved in those fields; the common knowledge of persons of ordinary skill prior to the Critical Date; the following publications and materials:

- U.S. Publication No. 2014/0191963 to Murakoshi ("Murakoshi") (APPLE-1004)
- U.S. Publication No. 2015/0348554 to Orr ("Orr") (APPLE-1005)

- U.S. Patent No. 4,744,249 to Stewart ("Stewart") (APPLE-1006)
- U.S. Publication No. 2009/0265671 to Sachs ("Sachs") (APPLE-1007)
- U.S. Publication No. 2015/0123949 to Li ("Li") (APPLE-1008)
- U.S. Publication No. 2010/0256947 to Kim ("Kim") (APPLE-1009)
- iFixit iPhone 6 Teardown Report (accessed at https://www.ifixit.com/Teardown/iPhone+6+Teardown/29213) ("iFixit") (APPLE-1010)
- iFixit iPhone 6 Teardown Report, archived by Internet Archive Wayback Machine on September 20, 2014, at https://web.archive.org/web/20140920142624/https://www.ifixit.com/Teardown/iPhone+6+Teardown/29213 (APPLE-1011)
- iFixit Teardown Navigation Page, archived by Internet Archive Wayback Machine on September 24, 2014, at https://web.archive.org/web/20140924024423/https:/www.ifixit.com/Teardown/ (APPLE-1012)
- Bond, "Take a look at the guts of the iPhone 6+ with the iFixit teardown video," Yahoo Finance News, Last Updated September 19, 2014 (accessed at https://finance.yahoo.com/news/2014-09-19-take-a-look-at-the-guts-of-the-iphone-6-with-the-ifixit-teardow.html) (APPLE-1013)

- Randewich, “Apple’s iPhone 6 Plus includes chips from Qualcomm, Skyworks: iFixit,” Yahoo Finance News Canada, Published September 18, 2014 (accessed at https://ca.news.yahoo.com/finance/news/apples-iphone-6-plus-includes-chips-qualcomm-sk-025450701--sector.html) (APPLE-1014)
- “Apple iPhone 6 teardown, in pictures,” The Telegraph (accessed at https://www.telegraph.co.uk/technology/apple/11109921/Apple-iPhone-6-teardown-in-pictures.html) (APPLE-1015)
- “Apple iPhone 6 teardown, in pictures,” The Telegraph, archived by Internet Archive Wayback Machine on September 20, 2014, at http://web.archive.org/web/20140920072019/https://www.telegraph.co.uk/technology/apple/11109921/Apple-iPhone-6-teardown-in-pictures.html (APPLE-1016)
- “iFixit opens up Apple’s iPhone 6 Plus to peek at its huge battery and the rest of its innards,” TNW, Published September 19, 2014 (accessed at https://thenextweb.com/news/ifixit-opens-up-apples-iphone-6-plus-to-peek-at-its-huge-battery-and-the-rest-of-its-innards) (APPLE-1017)
- Cunningham, “iFixit tears new iPhones apart, finds they’re pretty easy to fix,” Ars Technica, Published September 19, 2014 (accessed at

https://arstechnica.com/gadgets/2014/09/ifixit-tears-new-iphones-apart-finds-theyre-pretty-easy-to-fix/) (APPLE-1018)

- Hanson, "iPhone 6 Plus teardown confirms 1 GB of RAM and more," Tech Radar, Published September 19, 2014 (accessed at https://www.techradar.com/news/phone-and-communications/mobile-phones/iphone-6-plus-teardown-confirms-1gb-of-ram-and-more-1266277) (APPLE-1019)
- Lawler, "iFixit cracks open an iPhone 6 Plus to get at the massive battery inside," engadget, Updated September 18, 2014 (accessed at https://www.engadget.com/2014-09-19-iphone-6-plus-teardown.html) (APPLE-1020)
- Schiesser, "iFixit tears down the iPhone 6s, finds smaller battery, large Taptic Engine," Techspot, Published September 25, 2015 (accessed at https://www.techspot.com/news/62232-ifixit-tears-down-iphone-6s-finds-smaller-battery.html) (APPLE-1021)
- Nicholas, "Pop open this iPhone 6 and see where the magic oozes from … oh hello again, Qualcomm," The Register, Published September 19, 2014 (accessed at https://www.techspot.com/news/62232-ifixit-tears-down-iphone-6s-finds-smaller-battery.html) (APPLE-1022)

- Trenholm, “See inside the iPhone 6 and 6 Plus with new teardown,” CNET, Published September 19, 2014 (accessed at https://www.cnet.com/tech/mobile/see-inside-the-iphone-6-and-6-plus-with-new-teardown/) (APPLE-1023)
- Van Allen, “The iPhone 6 is Apple’s easiest-to-repair phone to date,” Techlicious,” Published September 19, 2014 (accessed at https://www.techlicious.com/blog/iphone-6-ifixit-teardown-repairability-score/) (APPLE-1024)
- Reddit Post “As requested: X-Ray of my iPhone 6 Plus – better image” in r/iphone, Published 9 years ago (accessed at https://www.reddit.com/r/iphone/comments/2r3n5n/as_requested_xray_of_my_iphone_6_plus_better_image/) (APPLE-1025)
- Reddit Post “iFixit begins live teardown of iPhone 6 Plus, revealing 2906 mAh battery” in r/iphone, Published 10 years ago (accessed at https://www.reddit.com/r/iphone/comments/2gtg5f/ifixit_begins_live_teardown_of_iphone_6_plus/) (APPLE-1026)
- iFixit Video, “The iPhone 6 Teardown Review,” YouTube, Published September 20, 2014, archived by Internet Archive Wayback Machine on September 22, 2014, at

https://web.archive.org/web/20140922002926/https:/www.youtube.com/watch?v=bGlWuf92LLI (APPLE-1027)

- iFixit Video, “The iPhone 6 Teardown Review,” YouTube, Published September 20, 2014, archived by Internet Archive Wayback Machine on December 14, 20214, at https://web.archive.org/web/20141214090834/https://www.youtube.com/watch?v=bGlWuf92LLI (APPLE-1028)
- iFixit User List, archived by Internet Archive Wayback Machine on July 18, 2014, at https://web.archive.org/web/20140718212129/https://www.ifixit.com/Users (APPLE-1029)
- Koebler, “How iFixit became king of the iPhone teardown,” Vice, Published November 3, 2017 (accessed at https://www.vice.com/en/article/7x4wxx/ifixit-iphone-x-teardown-behind-the-scenes) (APPLE-1030)
- Declaration of Nathaniel E. Frank-White (APPLE-1031)
- iFixit Home Page, archived by Internet Archive Wayback Machine on September 24, 2014, at https://web.archive.org/web/20140924094348/https://www.ifixit.com/ (APPLE-1032)

- iFixit iPhone 6 Plus Teardown, archived by Internet Archive Wayback Machine on September 24, 2014, at https://web.archive.org/web/20140924041128/https://www.ifixit.com/Teardown/iPhone+6+Plus+Teardown/29206 (APPLE-1033)
- Eric Silvka, "iPhone 6s Materials Analysis Confirms Stronger, Less Bendable Aluminum Alloy," MacRumors, August 19, 2015 (retrieved from https://www.macrumors.com/2015/08/19/iphone-6s-shell-aluminum-alloy/) (APPLE-1034)
- Wilmar Hernandez, *Improving the Response of a Rollover Sensor Placed in a Car under Performance Tests by Using a RLS Lattice Algorithm*, 5 Sensors 613-632 (2005) (APPLE-1035)
- Mark Serridge & Torben Licht, *Piezoelectric Accelerometer and Vibration Preamplifier Handbook* (1987) (APPLE-1036)
- Wong et. al, *Clinical Application of Sensors for Human Posture and Movement Analysis: a Review*, 31 Prosthetics and Orthotics International 62-75 (2007) (APPLE-1037)
- Majid Dadafshar, *Maxim Integrated Application Note 5830 - Accelerometer and Gyroscopes Sensors: Operation, Sensing, and Applications* (2014) (APPLE-1038)

- STI Vibration Monitoring, Inc., *Accelerometer Installation Guide – Field Application Note,* (2012) (APPLE-1039)
- Texas Instruments Application Report – 3-V Accelerometer Featuring TLV2772, SLVA040 (1998) (APPLE-1040)
- Dr. Hisham El-Sherif, Lecture 7: Piezoelectric Transducer slides (2010) (APPLE-1041)
- Artur Trosin, *Separation of Concerns vs. Single Responsibility Principle (SoC vs. SRP)*, (January 26, 2009) (APPLE-1042)
- Peri Tarr et al., *Workshop on Multi-Dimensional Separation of Concerns in Software Engineering*, ICSE '00 Proceedings of the 22nd International Conference on Software Engineering 809, 809 (2000) (APPLE-1043)
- Derek Greer, *The Art of Separation of Concerns*, Aspiring Craftsman Blog (January 3, 2008) (archived by Wayback Machine on November 11, 2011) (APPLE-1044)
- Hayim Makabee, *Effective Software Design: Separation of Concerns,* (February 5, 2012) (APPLE-1045)
- U.S. Publication No. 2014/0327526 to Bess (APPLE-1046)
- U.S. Publication No. 2011/0087454 to Lee (APPLE-1047)
- U.S. Publication No. 2015/0358696 to Yeo (APPLE-1048)

- PCT Publication No. WO2012058770 to Slupsky (APPLE-1049)
- M. Chan et al., *A review of smart homes- Present state and future challenges*, Computer Methods and Programs in Biomedicine, vol. 91 (2008) 55-81 (APPLE-1050)
- M. Vacher et al., *Complete sound and speech recognition system for heath and smart homes: Application to the recognition of activities of daily living*, New Developments in Biomedical Engineering, ed. Domenico Campolo, (2010) 1-26 (APPLE-1051)
- U.S. Publication No. 2010/00085216 to Ms (APPLE-1052)
- Ava Mutchler, *Voice Assistant Timeline: A Short History of the Voice Revolution*, voicebot.ai (July 14, 2017) (retrieved from https://voicebot.ai/2017/07/14/timeline-voice-assistants-short-history-voice-revolution/) (APPLE-1053)
- Merriam Webster Dictionary, Web Entry for "Accelerometer," (retrieved from https://www.merriam-webster.com/dictionary/accelerometer) (APPLE-1054)
- Merriam Webster Dictionary, Web Entry for "Sensor," (retrieved from https://www.merriam-webster.com/dictionary/sensor) (APPLE-1055)

- Haptic Preliminary Infringement Contentions (March 18, 2024), Case No. 1:23-CV-1351-DII (APPLE-1101)
- Haptic Response in Opposition to Apple's Rule 12(b)(6) Motion (February 5, 2024), Case No. 1:23-CV-1351-DII, Document 27 (APPLE-1104)
- Joint Claim Construction and Prehearing Statement (August 29, 2024), Case No. 3:24-cv-02296-JSC (after transfer to NDCal), Document 101 (APPLE-1107)
- Complaint for Patent Infringement and Jury Demand (November 6, 2023), Case No. 1:23-cv-01351-DII, Document 1 (APPLE-1108)

18. Note that my citations to non-patent literature throughout this Declaration reference the absolute page number added to the exhibit (as opposed to the original pagination of the document). For patent literature, I have used the column/line numbers or paragraph numbers.

19. Although this Declaration refers to selected portions of the cited references for the sake of brevity, it should be understood that these are examples, and that one of ordinary skill in the art would have viewed the references cited herein in their entirety and in combination with other references cited herein or cited within the references themselves. The references used in this declaration, therefore, should be viewed as being incorporated herein in their entireties.

20. Counsel has informed me that I should consider these materials through the lens of a person of ordinary skill in the art ("POSITA," which is discussed further in Section VI below) as of the Critical Date, and I have done so. Unless otherwise stated, my testimony below refers to the knowledge of a POSITA as of the Critical Date.

IV. SUMMARY OF CONCLUSIONS

21. This Declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions:

- **GROUND 1A:** Claims 1, 2 and 8-11 are obvious in view of Murakoshi and Stewart. *See infra,* Section IX.A.
- **GROUND 1B:** Claims 1-2, 4-5, and 8-11 are obvious in view of Murakoshi, Stewart, and Sachs. *See infra,* Section IX.B.
- **GROUND 1C:** Claims 1-2, 4-5, and 8-11 are obvious in view of Murakoshi, Stewart, Sachs, and Orr. *See infra,* Section IX.C.
- **GROUND 2A:** Claims 1-2 and 8-10 are obvious in view of Li and iFixit. *See infra,* Section IX.D.
- **GROUND 2B:** Claims 4, 5, and 11 are obvious in view of Li and iFixit. *See infra,* Section IX.E.

V. LEGAL PRINCIPLES

22. In forming my analysis and conclusions expressed in this Declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

A. Person of Ordinary Skill in the Art

23. I understand that the factors considered in determining the ordinary level of skill in a field of art include: the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art regarding solutions to such problems; and the sophistication of the technology at the time of the alleged invention's effective filing date. I understand that a person of ordinary skill in the art ("POSITA") is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above and knowledge of all relevant prior art references, including the references I cite in my analysis below.

B. Obviousness

24. I have been informed that a patent claim is invalid as "obvious" under 35 U.S.C. § 103 in light of one or more prior art references if it would have been obvious to a POSITA, taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long felt need" for the claimed invention, (ii)

commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) "copying" of the claimed invention by others.

25. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason to modify the single prior art reference, or combine two or more references, in order to achieve the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference or references themselves, the knowledge or "common sense" of one skilled in the art, or from the nature of the problem to be solved, and may be explicit or implicit from the prior art as a whole. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

26. I understand that an obviousness determination also requires that a POSITA would have had a reasonable expectation of success. This concept has been explained to me as relating to the relative likelihood or predictability—from the perspective of a POSITA—of successfully supplementing and/or modifying the prior art in a manner that would meet the claimed limitations of the patent being challenged (here the '300 patent). I understand that the expectation of success

need only be "reasonable" and, thus, does not require the absolute certainty gleaned from physically creating the proposed prior art modification.

C. Claim Construction Standard

27. It is my understanding that the claim construction standard includes construing the claim in accordance with the ordinary and customary meaning of such claim as understood by a person of ordinary skill in the art. As explained above, I was at least a person of ordinary skill in the art before the earliest filing date of challenged patents.

28. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their "broadest reasonable construction in light of the specification of the patent in which it appears." 37 C.F.R. § 42.100(b). In that regard, I understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by a POSITA. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. I also understand that the words of the claims should be interpreted as they would have been interpreted by a POSITA at the time of the invention was made (not today). Because I do not know at what date the invention as claimed was made, I have used the earliest priority date of U.S. Patent No. 9,996,738 as the

point in time for claim interpretation purposes. That date was February 13, 2015 ("the Critical Date").

29. It is my understanding that Apple and Haptic submitted a joint claim construction statement ("JCC") in the NDCal litigation and that Haptic also submitted infringement contentions in the litigation. I have reviewed these documents from the related district court proceeding. APPLE-1101 (Infringement Contentions shown in Appendices A-B); APPLE-1107 (Joint Claim Construction).

VI. PERSON OF ORDINARY SKILL IN THE ART

A. A POSITA's Ordinary Level of Skill

30. Based on my knowledge and experience in the field and my review of the '738 patent and its file history, I believe that a person of ordinary skill in the art as of the Critical Date ("POSITA") would have had a bachelor's degree in computer science, computer engineering, or a related field, and at least two to three years of practical computer programming or engineering experience, including experience developing user interface technologies. Additional graduate education could substitute for years of experience, or significant experience in the field could substitute for formal education. For example, a person with multiple years of experience in building or designing computer-human interfaces might be a POSITA despite not having formal education, because significant experience can substitute for education.

31. The POSITA described above would be capable of performing various design tasks related to systems that allow humans and computers to interact and would understand the basic structural and software components required to implement a human-computer interface. The POSITA would have at least a basic knowledge of how machines include electronics and circuitry to communicate with one another (for example in a "smarthome" device or virtual assistant). For example, this would include capabilities of well-known processors, sensors for input and actuators and displays for output, and how they worked together. From their education and/or experience, a POSITA would have a basic understanding of how to implement software or code including algorithms in a device to use those processors and sensors to receive user inputs of various types and to translate the user inputs into actions of the device.

32. Accordingly, my analysis and conclusions expressed in this Declaration are based on the perspective of a POSITA having this level of knowledge and skill. My education, technical expertise and personal knowledge discussed above in Section §II shows that I meet the qualifications of a POSITA.

B. A POSITA's Backgrounds Knowledge

1. Background of the Technology

33. As I will explain in more detail below in Section §VII, the '738 patent's inventors claim to have invented a "control system [that] enables a

mounting surface independent from the terminal device to become a controller for the terminal device" such that "[a] gesture by a user associated with the mounting surface controls activity of the terminal device, such as a knock on a wall lowering a thermostat." APPLE-1001, Abstract. But the inventors are mistaken. This technology was not new or inventive by the 2015 Critical Date of the '738 patent, and the '738 patent claims' recitations of common-sense characteristics of vibrational sensors and accelerometers does not add anything new to the technologies already in existence at the Critical Date. As I will explain below, the idea of a device using an accelerometer to detect vibrations of a surface caused by a user tapping on the surface and the device determining from the detected vibrations a command to control another device was well known before the '738 patent, as shown by prior art references such as Murakoshi and Li.

34. I have cited numerous patent documents and other non-patent literature throughout this declaration that support my understanding, each of them preceding the '738 patent.[4] A POSITA would have known of these references and

[4] In the limited situations in which I cite to a reference that postdates the Critical Date, I make note of this in a footnote and explain the use of the reference as adding context or providing additional discussion of well-known principles or ideas that were known prior to the Critical Date.

considered them representative examples regarding the state of the art. Accordingly, my obviousness analysis below in Sections §§IX.A-IX.E is informed by these references, as well as my personal knowledge and experience.

2. Devices for Performing Actions Based on Sensed Data

35. By the early 2000's technologies that provided automation and remote management of devices in the home were gaining in popularity. APPLE-1050, 1. For example, smart home devices include a wide range of products such as smart lights, thermostats, security cameras, and smart locks. These devices can be controlled remotely and can often be integrated into a larger smart home ecosystem. Development of miniature and wireless sensors aided in the growth of the smart home and virtual assistant devices. *Id.*, 2-3. In an example of a smart home setup, "the house and its various electrical appliances have been fitted with sensors, actuators, and/or biomedical monitors [and the] devices operate in a network" that reports data to a local or remote center for processing before the devices are automatically controlled. *Id.*, 3. Such systems involved various types of sensors for collecting and reporting information related to the operation of devices in the household and the actions of people in the house.

36. In particular, technologies for sensing vibrations and processing the vibration to perform an action in response were well-known before the Critical Date. For example, accelerometers and microphones positioned in or on the floor

were being used for fall-detection for at-risk patients. APPLE-1051, 5. Vibration data was also collected by remote and networked sensors for use in detecting structural issues in buildings, bridges and other structures. APPLE-1049, [0002]-[0003], [0037]-[0039]. Additionally, systems that receive user inputs of vibrations or touch to control one or more devices were gaining in popularity. *See e.g.*, APPLE-1046, Fig. 1 (showing person knocking on wall to control devices in a room), Fig. 4 (illustrating method steps including receiving vibration data, identifying a command, and generating a control signal based on the command and user location); APPLE-1048, Fig. 18 (showing a sensor node detects knocking sound gestures to remotely control another device); APPLE-1052, Fig. 2 (showing a user generated impact to a surface is detected by electronic device and used to control another device).

37. Beyond merely sensing vibrations from impacts to a surface or motions of a surface and performing an automatic response to the impact, by the Critical Date it was well known that devices that could be programmed to interpret patterns of vibrations, and other user inputs, to perform a particular action in response to a detected pattern of the user input. The ’738 patent itself describes many such systems in the Background section. APPLE-1001, 1:51-3:25. For example, the ’738 patent discusses U.S. Patent. No. 8,788,978 to Stedman et al., which describes “pinch zoom” functionality for use with “a touch screen, camera,

motion sensor, and proximity sensors." *Id.*, 2:45-52. The '738 patent also discusses World Intellectual Property Organization Publication No. WO2013165348 to Bess (APPLE-1046), which describes a system that captures "vibration data corresponding to a command tapped onto the surface by a user," and "identifying the command and a location of the user from the vibration data." *Id.*, 2:53-62. The '738 patent further discusses U.S. Patent Publication No. 2012/0249416 to Maciocci et al., which describes using a projector "worn on the body of the user to project onto surfaces," "tracking movements of the recognized body parts, applying a detection algorithm to the tracked movements to detect a predetermined gesture, [and] applying a command corresponding to the detected predetermined gesture." *Id.*, 3:5-15. In yet another example, the '738 patent discusses U.S. Patent Publication No. 2010/0019922 to Van Loenen, which describes interpreting "direction of movement of a hand stroking [an interactive] surface" as "a command to increase or decrease a parameter, such as the sound volume level of a television." *Id.*, 3:16-25.

38. Indeed, by the Critical Date there was a public demand for such user input-responsive devices. "Virtual assistants" or "smart home hubs" were swiftly gaining popularity by the mid-2010s. APPLE-1053, 4. These devices are designed to perform actions based on user inputs, often through voice commands or mobile

app controls. Many home assistant devices use voice recognition technology to understand and execute user commands.

3. Accelerometer Basics

39. Accelerometers have been in common since well before the Critical Date (*see e.g.*, U.S. Patent No. 2,311, 637 titled "Accelerometer" and filed in 1941) and have a variety of applications such as measuring vibration, shock, and acceleration. APPLE-1035, 613, 614-15. At a high level, accelerometers operate by measuring the displacement of a mass relative to its stationary housing. APPLE-1037, 64. This is commonly accomplished using a spring-mass accelerometer, which uses a spring to attach a mass to a housing. APPLE-1035, 614-15. The accelerometer's springs decrease the damping of the measurement signal (e.g., vibration, acceleration, or shock) by causing the mass to oscillate when a force is applied. *Id.*

40. By equating Newton's law—the force acting on a body's mass is equal to the body's mass times its acceleration—with Hooke's law—the force acting on a spring is equal to a spring constant times the spring's displacement—acceleration can be measured indirectly by measuring spring displacement (i.e., the displacement of the mass). APPLE-1035, 614-15. Thus, when the accelerometer is attached to the surface of an object, the acceleration (or vibration) of the object can be measured. APPLE-1036, 11, 13-14.

41. Spring-mass accelerometers use different sensing elements such as capacitive and piezoelectric elements. APPLE-1038, 12-14. In piezoelectric accelerometers, the mass attaches to the piezoelectric sensing element. *Id.*; *see also* APPLE-1041, 25. The mass and sensing element are then attached to the accelerometer housing through a spring and dampers. APPLE-1041, 29, 31. The base of the sensor's housing attaches to an object so that motion of the object "results in the motion of the mass relative" to the housing. *Id.*, 32; *see also* APPLE-1046, [0013] ("Accelerometers 20 are disposed in area 4 with a physical connection to one or more solid surfaces 6 to allow vibrations to transmit from the surfaces 6 tapped by users 2 to the surfaces 6 in physical contact with accelerometers 20"). The piezoelectric element acts as a transducer, converting the force it experiences when moving to a proportional electrical charge measurable by an electronic circuit. APPLE-1041, 215-30.

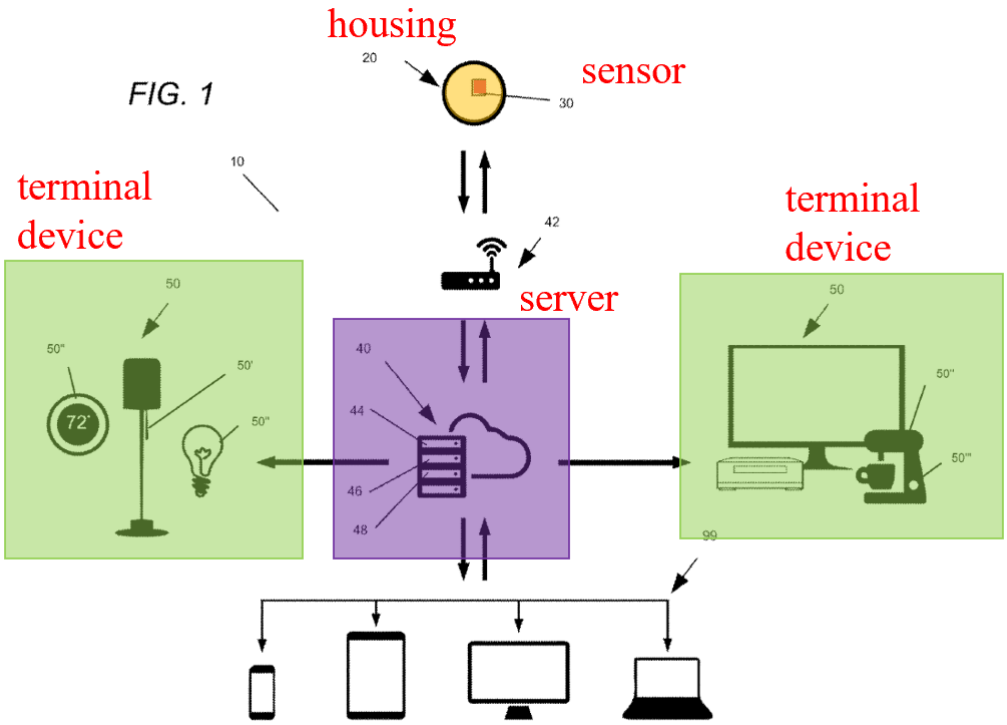
42. In capacitive accelerometers, acceleration is related to the change in capacitance of a moving mass. APPLE-1038, 2-3. The moveable mass attaches via springs to electrodes fixed to the accelerometer's housing on both ends of the mass's axis of motion. *Id.* When a force causes the mass to be displaced (e.g., by vibration, acceleration, or shock), the capacitance between each electrode and the mass changes and is measurable by an electronic circuit. *Id.*, 2-5.

43. When used to measure vibration, accelerometer performance suffers if the accelerometer housing is not properly mounted to the surface of the object under measurement. APPLE-1039, 1. It was well known by the Critical Date to mount accelerometers to a surface using a variety of fasteners, including magnets, welding, straps, adhesives, hook and loop fasteners, suctions cups, screws, or bolts. APPLE-1049, [0028], APPLE-1048, [0082]. Accelerometers have a sensing range (i.e., bandwidth) that reduces when the sensor is not solidly and directly attached to the object under measurement. APPLE-1040, 7; APPLE-1039, 1. Because vibrations outside the bandwidth are not measured by the accelerometer, the sensor should be solidly fixed to the object under measurement. APPLE-1039, 7.

VII. OVERVIEW OF THE '738 PATENT

A. Overview of the '738 Patent

44. The '738 patent is about "a system to detect gestures on a mounting surface and to generate commands for the terminal device based on detected gestures." APPLE-1001, 1:45-48. The system allows a user to control a terminal device by knocking on a surface on which a housing and sensor are mounted, for example "a knock on a wall lowering a thermostat." *Id.*, Abstract. I



APPLE-1001, Fig. 1 (annotated)

45. As illustrated in Fig. 1, "the control system 10 includes a housing 20 engaged to a mounting surface 22, a sensor 30 within the housing 20, a server in communication with the sensor 30, and a terminal device 50 in communication with the server 40." APPLE-1001, 6:49-53. Fig. 1 also includes various "interfaces," labeled 99. The '738 patent explains that these interfaces "allow the user to adjust the settings of the control system." APPLE-1001, 6:53-58. The interfaces are not referenced in or relevant to the claims of the '738 patent, and the interfaces 99 are not considered "terminal devices.

46. The ’738 patent’s system “convert[s] any independent mounting surface [22] into a controller for a terminal device” by fixing a housing 20 to the surface by “an engagement means [24].” *Id.*, 4:32-44. “FIG. 4 shows an embodiment of the engagement means 24 being comprised of an attachment means 26 between the housing 20 to the mounting surface 22 and a transmission portion 28 connecting the sensor 30 to the housing 20.” *Id.*, 6:67-7:4. The ’738 patent describes that “attachment means 26 can be an adhesive, mechanical fasteners, threaded screws or other components to hold the housing 20 to the mounting surface 22” and “transmission portion 28 can be comprised of frames and brackets 38 or a spring loaded portion.” *Id.*, 7:4-9.[5] “Any sound or vibration of the mounting surface 22 is transmitted to the sensor 30” through the transmission portion. *Id.*, 7:11-13.

[5] Because the frames and brackets 38 are part of the transmission portion, they are highlighted in red in Fig. 4, below. APPLE-1001, 7:7-9.

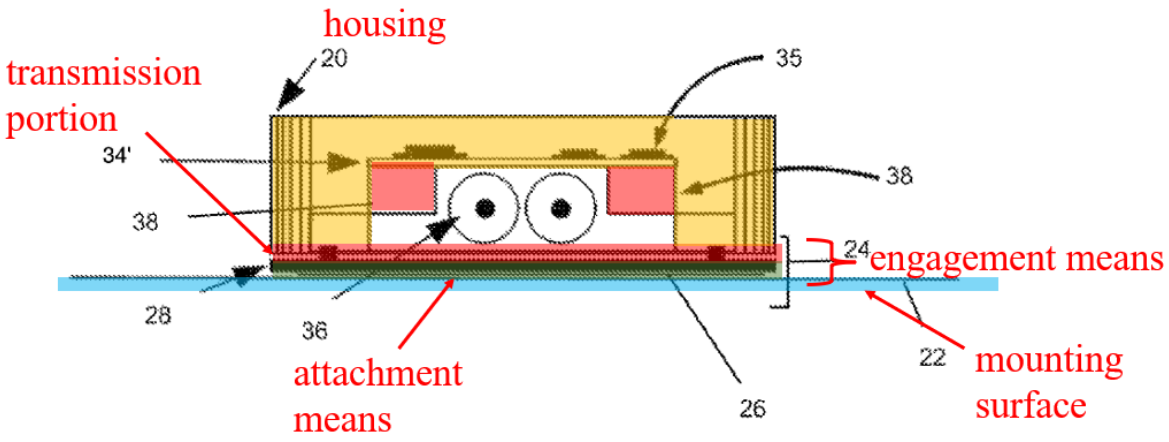


FIG. 4

APPLE-1001, Fig. 4 (annotated)

47. The "sensor 30 form[s] an interactive zone 32 defined by a range 34 of the sensor 30" and further that "[a] contact interaction with the mounting surface 22 within the interactive zone 32 is detected by the sensor 30 as data signals." APPLE-1001, 7:35-39. "The contact interaction 60 generates the data signals 70 of the sensor 30 through the transmission portion 28 of the housing 20." *Id.*, 5:65-66. "FIGS. 5 and 6 show the interactive zone 32 aligned with the mounting surface 22, in particular, the interactive zone 32 is coplanar with the mounting surface 22." *Id.*, 7:39-41.

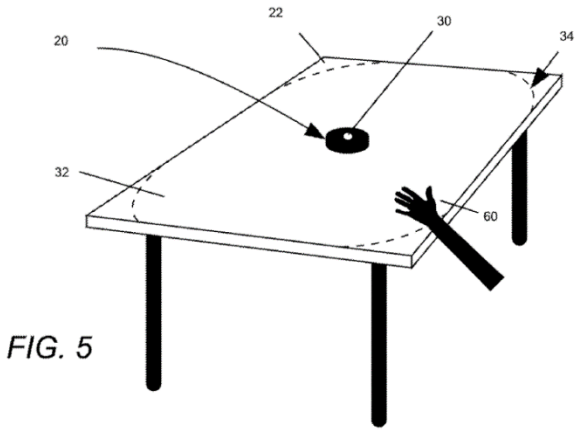


FIG. 5

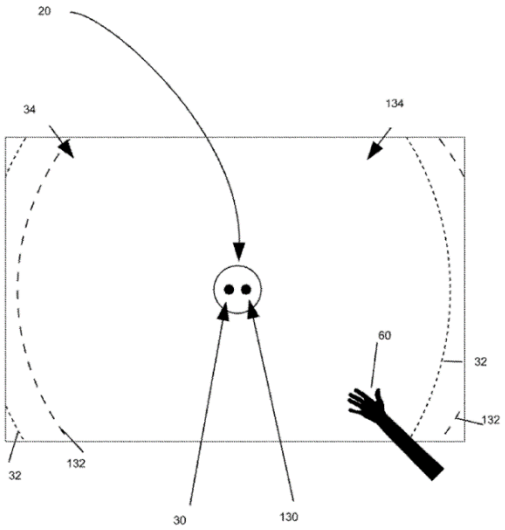


FIG. 6

APPLE-1001, Figs. 5 and 6

48. The ’738 patent states that “the contact interaction 60 is comprised of an impact or plurality of impacts associated with the mounting surface 22.” *Id.*, 8:53-55. “The control system 10 determines the data pattern 80 for contact interactions 60 … [d]ifferent gestures of a user can be used by the present invention for controlling activity of the terminal device 50.” *Id.*, 9:4-18.

49. The ’738 patent states that “the server 40 can be comprised of a routing module 44, a processing module 46 being connected to the routing module 44, and an output module 48 connected to the processing module 46.” *Id.*, 9:40-43. “[T]he routing module 44 receives the data signals 70 … correspond[ing] to the contact interaction 60 associated with the mounting surface 22.” *Id.*, 9:44-47. “The processing module 46 determines the data pattern 80 corresponding to the data signals 70 of the contact interaction 60 [and] matches the data pattern 80 with

a gesture profile 90 [] associated with a command, such as power off or change channels or dim intensity." *Id.*, 9:47-52. The '738 patent describes that "the output module 48 transmits the command to the terminal device 50." *Id.*, 52-53.

50. For example, the '738 patent describes "[k]nocking twice on a tabletop can be converted by the control system 10 into a command to change channels on a television or to lower the temperature of a thermostat or to create an entry in an online calendar software program on a computer." *Id.*, 10:7-11.

B. Summary of Prosecution History of the '738 Patent

51. During prosecution, the application that eventually issued as the '738 Patent was rejected over U.S. Patent No. 5,103,085 and U.S. Publication No. 2015/0100167. APPLE-1002, 97-110. The application was allowed after significant amendments to the independent claims to incorporate subject matter of various dependent claims. *Id.*, 129-148, 161-166. Both independent claims were amended to specify the claimed sensor comprises an accelerometer, the interactive zone "overlaying said mounting surface outside a perimeter of said housing;" to describe the contact interactions on the mounting surface and associated data signals; and to describe the engagement means, attachment means, and transmission portion in a wherein clause. *Id.*, 133-139.

52. In particular, the Applicant amended the claims to expressly recite that the "contact interaction" is "an impact ***on*** said mounting surface" to

distinguish over the prior art cited by the Office that showed impact on a separate surface associated with the mounting surface. *See* APPLE-1002, 129-148; APPLE-1001, 8:50-62, Fig. 5.

53. Additionally, in the response to the rejection, the Applicant argued that "[t]here is no suggestion, motivation, or teaching for the transmission portion of the engagement means and relationship of the sensor relative to the mounting surface set by the transmission portion." *Id.*, 142-143. Applicant further argued that "[t]he present invention only enhances one surface, using a particular type of sensor, an accelerometer." *Id.*, 143. However, as will be explained below, these features—an accelerometer held within a housing affixed to a surface and having an interactive zone extending outside of its housing for detecting data signals associated with vibrations caused by impacts to a surface—are taught in one or more of Murakoshi, Orr, Stewart, Li, and iFixit, none of which the Office considered.

VIII. INTERPRETATIONS OF THE '738 PATENT CLAIMS AT ISSUE

54. I have been asked to provide my interpretation of the following terms of the '738 patent set forth below. In providing the following interpretations, I have carefully considered and applied the claim construction standard referred to in §V.C above. Below, I offer my analysis of how a POSITA would have construed certain claim features of the '738 patent as part of "Apple's Construction."

Additionally, I discuss Haptic's preliminary contentions as they relate to Haptic's apparent interpretation of the same claim terms. Both Apple's construction and Haptic's construction are applied in the below grounds as specified, and the claims are invalid under either construction, as I will explain below.

55. I have additionally been asked to provide my interpretation of these terms as functional or structural limitations as they pertain to §112(f) (also referred to as means-plus-function limitations), which I have been informed applied when claim limitations are recited in terms of their function instead of their structure. I have additionally been informed that, for terms that are subject to interpretations as means-plus-function limitations, the corresponding structure in the specification is what defines the scope of the limitation.

56. In the below table, in the column labeled "Apple's Construction," I have presented interpretations for each of the terms I believe should be interpreted as means-plus-function limitations, which are applied to the prior art below. The interpretations presented in the table below under "Apple's Construction" represent my analysis regarding a POSITA's understanding and interpretation of these claim terms.

57. I have reviewed the Joint Claim Construction and Prehearing Statement (APPLE-1107) from the NDCA litigation. Additionally, Haptic has served preliminary infringement contentions further illustrating Haptic's claim

interpretations. *See* APPLE-1101 (Haptic's preliminary infringement contentions and claim charts in Appendices A-B). In the below table, I have included the parties' constructions based on the JCC (APPLE-1107).

58. I address each of Apple's claim constructions further below, and the claim constructions are summarized in the following table.

Claim Term	Apple's Construction	Haptic's Construction
"engagement means … wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion" (Claim 1)	**Subject to 112(f):** **Function:** • Engagement • Attaching or holding the housing to the mounting surface • Transmitting data signals from the attachment means to the sensor • Connecting said sensor to said attachment means of said housing to set rigid position of said sensor relative to said mounting surface **Structure:**	**Subject to 112(f):** **Function:** • Engagement • Attachment or holding the housing to the mounting surface • Connecting the sensor to the housing **Structure:** • An "attachment means" and a "transmission portion" • Adhesive, mechanical fasteners, threaded screws, screw holes, or other components to hold the housing

Claim Term	Apple's Construction	Haptic's Construction
	• Adhesive, mechanical fasteners, or threaded screws • Transmission portion 28, which includes frames and brackets 38 or a spring loaded portion, each of which are comprised of a material with flexibility different than the mounting surface and reduce damping • Equivalents thereof (APPLE-1001, 4:46-51, 4:65-66, 6:67-7:17, 7:27-29, 8:9-52, FIGS. 3-9; APPLE-1002, 100-102, 141)	to the mounting surface • A portion connecting the sensor to the housing, which can be comprised of frames, brackets, a spring loaded portion, or a material with flexibility different than the materials of the mounting surface or surface of the contact interaction • Equivalents thereof
"said contact interaction being comprised of an impact on said mounting surface" (Claim 1)	"where the contact interaction is a user impact (e.g., a knock) directly on the mounting surface" (APPLE-1001, 1:40-48, 4:31-41, 6:3-6, 6:33-48, 7:35-8:65, FIGS. 5-9; APPLE-1002, 103-104, 133, 142-145)	No construction necessary
"routing module … said routing module receiving said data signals from said sensor" (Claim 1)	**Subject to 112(f):** **Function:** • Routing	No construction necessary

Claim Term	Apple's Construction	Haptic's Construction
	• Receiving the data signals from the sensor **Structure:** • Routing module 44 • Equivalents thereof (APPLE-1001, 5:25-31, 9:40-45, 10:59-67, 11:20-24, FIG. 1)	
"processing module … said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile" (Claim 1)	**Subject to 112(f):** **Functions:** • Processing • Determining a data pattern corresponding to the data signals • Matching the data pattern with a gesture profile **Structure:** • Processing module 46 • Equivalents thereof (APPLE-1001, 5:25-38, 8:66-9:14, 9:40-50, 10:33-36, 10:59-11:2, FIGS. 1-2)	No construction necessary

Claim Term	Apple's Construction	Haptic's Construction
"output module … said output module transmitting said command to said receiving module" (Claim 1)	**Subject to 112(f):** **Function:** • Outputting • Transmitting the command to said receiving module **Structure:** • Output module 48 • Equivalents thereof (APPLE-1001, 5:25-28, 5:36-38, 9:40-61, 10:59-64, 11:6-9, FIG. 1)	No construction necessary
"terminal device" (Claim 1)	"a remote device" (APPLE-1001, Abstract, 1:40-48, 1:54-66, 2:3-8, 2:21-24, 2:38-40, 3:26-29, 3:61-63, 4:31-36, 5:39-55, 6:3-6, 6:33-48, 6:60-61, 9:65-67, 11:43-49, Claim 8, FIG. 1)	No construction necessary
"receiving module" (Claim 1)	**Subject to 112(f):** **Function:** • Receiving **Structure:** • Receiving module 52 • Equivalents thereof	No construction necessary

Claim Term	Apple's Construction	Haptic's Construction
	(APPLE-1001, 5:43-36, 5:51-53, 10:63-64, 11:6-9)	
"means for initiating activity of said terminal device corresponding to said command" (Claim 1)	**Subject to 112(f):** **Function:** • Initiating activity of said terminal device corresponding to said command **Structure:** • "switch or other actuating mechanism that changes the status of a terminal device" and equivalents thereof (APPLE-1001, 5:53-55)	Same as Apple's

A. "engagement means…"

59. Claim 1 recites "a housing having an engagement means for a mounting surface" and then further defines the engagement means in the final clause, stating "wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said

mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion." APPLE-1001, 12:3, 35-45.

60. In my opinion, this term is governed by §112(f). The limitation uses the term "means for" and is recited in terms of its function (engaging the "housing" with the "mounting surface," "connecting said sensor to said attachment means of said housing," "set[ting] a rigid position of said sensor relative to said mounting surface," and transmitting "data signals" to a sensor) instead of its structure. *Id*. I understand that when a term recites "means for" there is a rebuttable presumption that the claim is governed by §112(f). In this case, the presumption is appropriate.

61. In the specification, the '738 patent describes that "[t]he housing has an engagement means for a mounting surface, such that the housing can be placed exterior, underneath or interior to the mounting surface" and that "[t]he engagement means can include an attachment means between the housing to the mounting surface and a transmission portion connecting the sensor to the housing." APPLE-1001, 4:42-43, 4:46-49; *see also id.*, 6:67-7:9 (similar), Figs. 3-9 (illustrating housings and mounting surfaces). The '738 patent describes, with reference to Figure 4 (reproduced below), the structures associated with each of the "attachment means" and the "transmission portion." In particular, the '738 patent describes that "[t]he attachment means 26 can be an adhesive, mechanical fasteners, threaded screws or other components to hold the housing 20 to the

mounting surface." *Id.*, 7:4-7. The '738 patent also describes that "the transmission portion 28 can be comprised of frames and brackets 38 or a spring loaded portion…so as to reduce damping." *Id.*, 7:7-9; *see also id.*, 4:49-51. "The transmission portion 28 can be comprised of a rigid material, such as an injection molded frame with flexibility different than the materials of the mounting surface 11." *Id.*, 8:20-23.

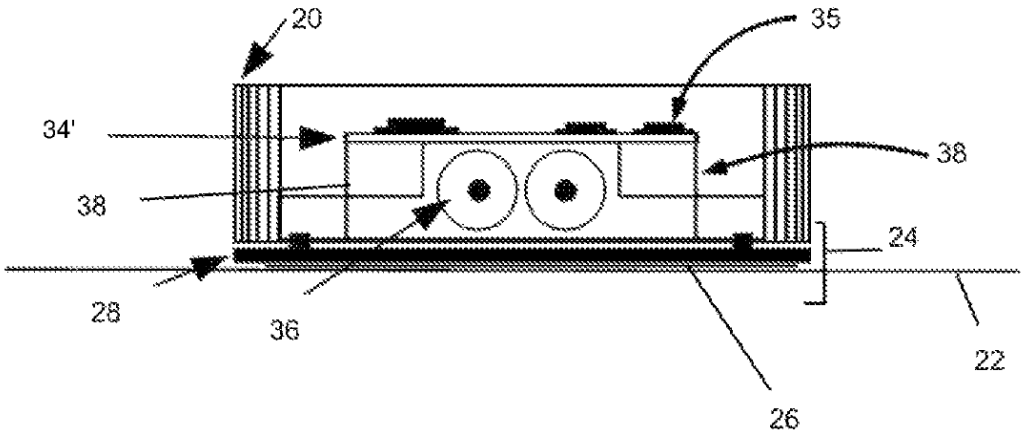


FIG. 4

APPLE-1001, FIG. 1

62. In the same section of the patent, the '738 patent also describes the claimed functions of the engagement means (made up of the attachment means and the transmission portion). The '738 patent describes that "[t]here is a rigid positioning of the sensor 30 relative to the mounting surface 22 through the housing 20" so that "[a]ny sound or vibration of the mounting surface 22 is

transmitted to the sensor 30." *Id.*, 7:9-13, 7:27-29; *see also id.*, 4:65-66 ("The contact interaction generates the data signals of the sensor through the transmission portion of the housing"), 8:9-12 ("The engagement means 24 of the housing 20 is cooperative with the sensor 30 so that any contact interaction generates data signals of the sensor through the transmission portion 28 of the engagement means 24."). Additionally, "[t]he engagement means 24 attaches the sensor 30 and reduces damping so that sensor 30 more accurately detects the mounting surface 22" and "[t]he transmission portion 28 affects sound or vibrations or other stimuli from the mounting surface 22 to the sensor." *Id.*, 7:13-17; *see also id.*, 8:16-18.

63. Based on the '738 patent's disclosure, a POSITA would have understood the corresponding structure for the recited "engagement means" encompasses "adhesive, mechanical fasteners, threaded screws" (APPLE-1001, 7:1-7) and "frames and brackets 38 or a spring loaded portion" (APPLE-1001, 7:7-9), and equivalents thereof that attach the housing to the mounting surface, connect the sensor to the attachment means of the housing, set a rigid position of the sensor relative to the mounting surface, and transmit data signals from the attachment means to the sensor, as claimed.

64. This construction of the term "engagement means" under §112(f) is consistent with the treatment of the term "engagement means" during the prosecution of the '738 patent. During prosecution, the Examiner issued a

statement explaining that the claim element "engagement means" was being interpreted under 35 U.S.C. §112(f) and stated that the corresponding structure was understood to be "an attachment means between the housing to the mounting surface" based on the disclosure in the application as filed. APPLE-1002, 100-102. The applicant responded stating:

> The means + function format is confirmed… Paragraphs 44-45 recite the attachment means 26 and transmission portion 28 corresponding to the engagement means 24. The structures corresponding to the attachment means 26 include an adhesive, mechanical fasteners, threaded screws or other components to hold the housing 20 to the mounting surface 22.

Id., 141. The construction offered by APPLE is consistent with the applicant's stated intent for "engagement means" to invoke §112(f) and to have a corresponding structure of "adhesive, mechanical fasteners, threaded screws" and "transmission portion 28" and equivalents thereof. *Id.*

65. As I explain below, there is significant overlap between the '738 patent's disclosed structures corresponding to the engagement means and the teachings in the prior art.

B. "said contact interaction being comprised of an impact on said mounting surface"

66. In my opinion, the claim limitation "said contact interaction being comprised of an impact on said mounting surface" would have been understood by a POSITA as "where the contact interaction is a user impact (e.g., a knock) directly on the mounting surface" in order to be consistent with the disclosure of the '738 patent specification and the treatment of the term during prosecution of the '738 patent. APPLE-1001, 1:40-48, 4:31-41, 6:3-6, 6:33-48, 7:35-8:65, FIGS. 5-9; APPLE-1002, 103-104, 133, 142-145.

67. The '738 patent describes "a manual control system" that allows a user to control a terminal device using "a control system on an exterior mounting surface independent from the terminal device to be controlled." APPLE-1001, 1:40-45. The system "detect[s] gestures on a mounting surface and … generate[s] commands for the terminal device based on detected gestures." *Id.*, 1:46-48. The '738 patent is clear that the mounting surface is "[a] physically separate mounting surface" such that the invention can "convert any independent mounting surface into a controller for a terminal device." *Id.*, 4:31-41; *see also id.*, 6:3-6 ("The gesture related to the mounting surface controls the terminal device, even as the mounting surface is independent from the terminal device"), 6:33-38, 6:45-48. The '738 further explains the relationship between the housing and the mounting surface where a contact interaction is detected:

> The contact interaction on the mounting surface 22 is detected by the sensor 30 on the mounting surface 22. In one example, the housing 20 rests on a table, and knocking on the tabletop can control the terminal device 50. The tabletop for knocking and the mounting surface 22 are the same structure.

Id., 7:42-47; *see also* Figs. 5-6. Other positions of the device are described in the '738 patent in relation to Figures 7-9. *Id.*, 7:48-8:65. For example, Figure 7 depicts an embodiment in which "[t]he contact interaction is **on the wall surface opposite** the mounting surface 22, but the knocking on the wall surface is transmitted to the mounting surface 22 and then to the sensor 30." *Id.*, 7:53-56 (emphasis added). Similarly, Figure 8 depicts an embodiment in which "[t]he contact interaction is on the tabletop, **opposite to** the mounting surface 22 [and the] knocking on the tabletop is transmitted to the mounting surface 22 on the bottom of the table and to the sensor 30." *Id.*, 7:58-61. Figure 9 shows an embodiment in which the housing is integral with the mounting surface so that "[t]he mounting surface 22 is within the table, and the tabletop is not the mounting surface 22." *Id.*, 7:61-64. The '738 patent describes that in these embodiments, the "contact interaction is associated with the mounting surface… even if the contact interaction is not always directly on the mounting surface." *Id.*, 7:64-8:1.

However, during prosecution, the applicant clearly indicated that the claims cover only the embodiments in which the contact interaction is directly on the mounting surface, and not embodiments where the contact interaction occurs elsewhere and is merely associated with the mounting surface.

68. During prosecution, the claims were rejected in view of references that showed a housing of a touch panel (housing) installed onto a window (mounting surfacer). APPLE-1002, 103-104. The rejection mapped the limitation "wherein a contact interaction associated with the mounting surface within the interaction zone is detected by the sensor as data signals" to the references stating "the user touch[es] the window 156 coming within the range of the photoelectric proximity switch panel 150." *Id.*, 103-104.

69. In response to the rejection, the applicant amended the claim to distinguish over the references, adding the language "said contact interaction being comprised of an impact on said mounting surface." *Id.*, 133. The applicant argued that the amended claim distinguished over the cited references because the references "suggest[] multiple sensors and multiple surfaces for confirming meaningful gestures" while "[t]he present invention only enhances one surface." *Id.*, 142-145. The applicant's amendment to the claim to specify "said contact interaction being comprised of an impact **on** said mounting surface" clearly indicates that the limitation is intended to be construed as requiring a user impact

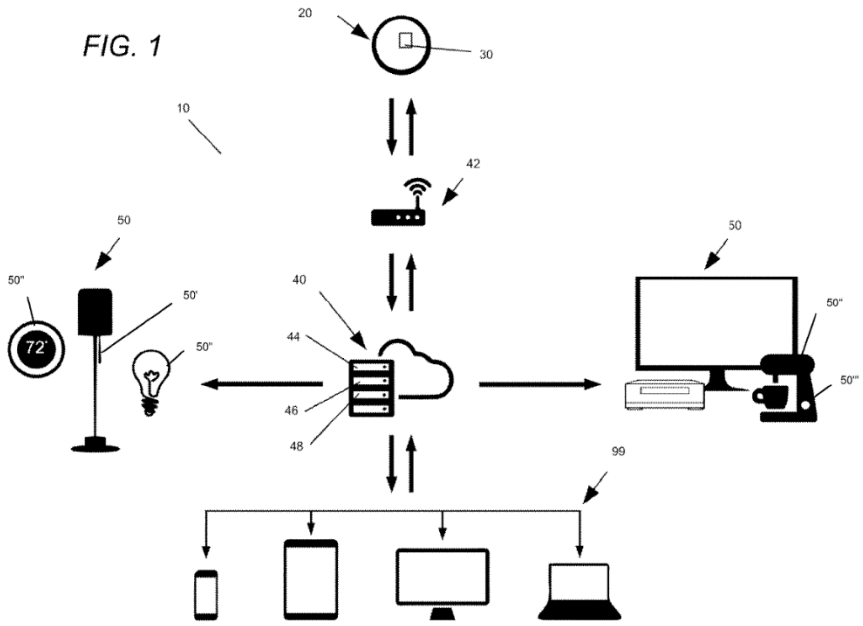
directly on the mounting surface, and not to mean any of the other embodiments that place the impact elsewhere.

70. Accordingly, Apple's construction of "where the contact interaction is a user impact (e.g., a knock) directly on the mounting surface" is consistent with the specification and prosecution history of the '738 patent, and a POSITA would have understood the claim limitation "said contact interaction being comprised of an impact on said mounting surface" to have this meaning.

C. "routing module … said routing module receiving said data signals from said sensor"

71. In my opinion, this term is governed by §112(f). Although the limitation does not use the term "means for," it is my opinion that a POSITA, considering the claims, specification, and file history, would consider the term "routing module" not to be a term used by a POSITA to designate either a particular structure or a class of structures. While a POSITA is familiar with the use of software, codes, or algorithms for manipulation of information, a "routing module" does not invoke a class of structures, and is not understood by a POSITA to refer to a class of structures. Thus, the term "module" is a nonce term, and the term is governed by §112(f). A POSITA would have understood the "routing module" to have the functions of routing and receiving the data signals from the sensor, and to have the corresponding structure of a "routing module 44" and equivalents thereof. APPLE-1001, 5:25-31, 9:40-45, 10:59-67, 11:20-24, FIG. 1.

72. The specification consistently describes the routing module in functional terms: "the server 40 can be comprised of a routing module 44, a processing module 46 being connected to the routing module 44, and an output module 48 connected to the processing module 46" and "the routing module 44 receives the data signals 70 from the sensor 30." APPLE-1001, 9:40-45; *see also id.*, 10:59-67 ("In some embodiments, the server 40 is comprised of a routing module 44…[t]he data signals 70 are received with the routing module 44 of the server, and the processing module 46 determines a data pattern 80 corresponding to the data signals 70 of the contact interaction 60."), 11:20-24 (explaining that in embodiments with an additional sensor, "the step of receiving the data signals from the sensor with the routing module further comprises receiving the additional data signals 170 from the additional sensor with the routing module."). Figure 1 of the '738 patent illustrates the routing module44 as an element or component of the server.



APPLE-1001, FIG. 1

73. As I explain below, there is significant overlap between the ’738 patent’s claimed function of the routing module and the teachings in the cited prior art.

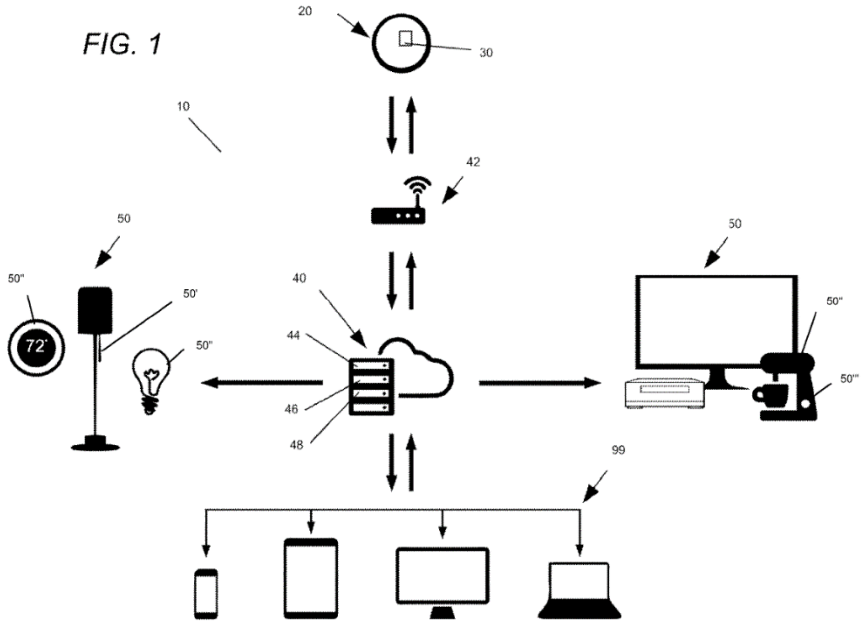
D. “processing module … said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile”

74. In my opinion, this term is governed by §112(f). Although the limitation does not use the term “means for,” it is my opinion that a POSITA, considering the claims, specification, and file history, would consider the term “processing module” not to be a term used by persons of skill in the art to designate either a particular structure or a class of structures. While a POSITA is

familiar with the use of software, codes, or algorithms for manipulation of information, a "processing module" does not invoke a class of structures, and is not understood by a POSITA to refer to a class of structures. Thus, the term "module" is a nonce term, and the term is governed by §112(f). A POSITA would have understood the "processing module" to have a functions of processing, determining a data pattern corresponding to the data signals, and matching the data pattern with a gesture profile, and to have a corresponding structure of "processing module 46" and equivalents thereof. APPLE-1001, 5:25-38, 8:66-9:14, 9:40-50, 10:33-36, 10:59-11:2, FIGS. 1-2.

75. The specification consistently describes the processing module in functional terms: "the server 40 can be comprised of a routing module 44, a processing module 46 being connected to the routing module 44, and an output module 48 connected to the processing module 46" and "[t]he processing module 46 determines the data pattern 80 corresponding to the data signals 70 of the contact interaction 60 [and] also matches the data pattern 80 with a gesture profile." APPLE-1001, 9:40-50; *see also id.*, 10:60-11:2 (similar), 11:24-27 ("With a plurality of sensors, the step of determining the data pattern 80 further comprises determining the data pattern corresponding to the data signals 70 and the additional data signals 170 with the processing module 46."). Accordingly, as

illustrated in Fig. 1, the ’738 patent describes the processing module 46 as an element or component of the server.



APPLE-1001, FIG. 1

76. The ’738 patent explains that in an example, “when the terminal device 50 is a television, a contact interaction 60 of two knocks can be detected as data signals 70 to generate a data pattern 80 [which] can be matched to a gesture profile 90 associated with changing channels up one channel.” *Id.*, 9:53-58.

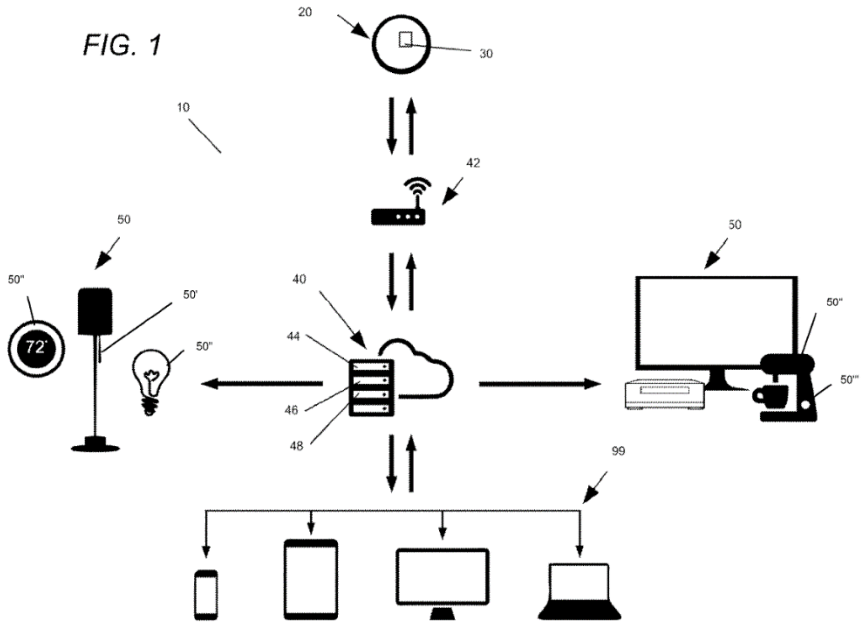
77. As I explain below, there is significant overlap between the ’738 patent’s claimed function of the processing module and the teachings in the cited prior art.

E. "output module … said output module transmitting said command to said receiving module"

78. In my opinion, this term is governed by §112(f). Although the limitation does not use the term "means for," it is my opinion that a POSITA, considering the claims, specification, and file history, would consider the term "output module" not to be a term used by persons of skill in the art to designate either a particular structure or a class of structures. While a POSITA is familiar with the use of software, codes, or algorithms for manipulation of information, an "output module" does not invoke a class of structures, and is not understood by a POSITA to refer to a class of structures. Thus, the term "module" is a nonce term, and a POSITA would have understood the "output module" has the functions of outputting, and transmitting the command to the receiving module and has the corresponding structure of "output module 48" and equivalents thereof. APPLE-1001, 5:25-28, 5:36-38, 9:40-61, 10:59-64, 11:6-9, FIG. 1

79. The specification consistently describes the output module in functional terms: "the server 40 can be comprised of a routing module 44, a processing module 46 being connected to the routing module 44, and an output module 48 connected to the processing module 46" and, after the processing matches a data signal to a gesture profile associated with a command, "the output module 48 transmits the command to the terminal device 50." APPLE-1001, 9:40-53; *see also id.*, 10:59-64 (similar), 11:7-9 ("The method includes transmitting the

command to the receiving module 52 of the terminal device 50 with the output module 48 of the server 40"). Figure 1 of the '738 patent illustrates the output module 48 as an element or component of the server.



APPLE-1001, FIG. 1

80. As I explain below, there is significant overlap between the '738 patent's claimed function of the output module and the teachings in the cited prior art.

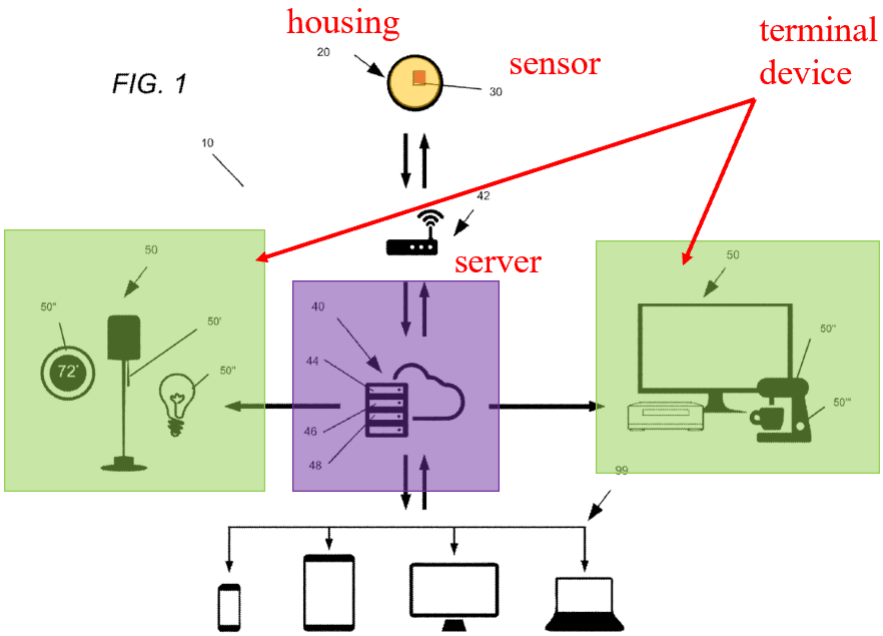
F. "terminal device"

81. In my opinion, the term "terminal device" would have been understood by a POSITA as "a remote device" based on the treatment of the term in the '738 patent specification. APPLE-1001, Abstract, 1:40-48, 1:54-66, 2:3-8,

2:21-24, 2:38-40, 3:26-29, 3:61-63, 4:31-36, 5:39-55, 6:3-6, 6:33-48, 6:60-61, 9:65-67, 11:43-49, Claim 8, FIG. 1.

82. The ’738 patent consistently describes the terminal device as separate from the housing of the control system. *See e.g., id*., Abstract (“The control system enables a mounting surface independent from the terminal device to become a controller for the terminal device [through] a command transmitted to the terminal device to control activity of the terminal device.”), 3:61-63 (“It is another object of the present invention to provide an interactive control system based on physical impact on a surface independent from the terminal device”), 4:31-36 (“Embodiments of the control system of the present invention convert any independent mounting surface into a controller for a terminal device. A physically separate mounting surface, such as a wall or table surface, can be used to activate and deactivate a television or light fixtures, without the user touching either appliance”), 6:33-48, 11:43-49. Further, the types of devices that the ’738 patent lists as examples of terminal devices are clearly devices remote to the sensor and housing: “television, lighting fixture, thermostat or laptop.” *Id.,* 1:40-48; *see also id.,* 1:54-2:8; 5:39-55; 9:65-67 (describing terminal devices including “a television, stereo, or coffee machine”). Further, the ’738 patent contextualizes the claimed sensor system as an improvement on “a remote control device.” *Id.*, 1:54-56, 2:3-8, 2:21-24, 2:38-40, 3:26-29. “Existing control systems include distinct remote

control devices dedicated to and associated with the particular output or terminal device to be controlled." *Id.*, 1:56-58.



APPLE-1001, Fig. 1 (annotated)

83. The '738 patent illustrates the terminal devices as separate devices (e.g., remote devices) from the housing and sensor device. *See* APPLE-1001, Fig. 1 (above) and Fig. 4 (showing the housing and sensor device, without any terminal device integrated therein). The '738 patent consistently describes that "[t]he command is transmitted to the terminal device." *Id.*, 6:3-6. Further, the language of claim 8, reciting "wherein said terminal device is comprised of one device selected from a group consisting of: a television, a thermostat, a computer, a software system, a game console, a fan, a mattress adjustor, an alarm clock, and a

lighting fixture" makes clear that the "terminal device" claimed is a "remote device."

84. Accordingly, Apple's construction of "terminal" is consistent with the specification of the '738 patent, and a POSITA would have understood the claim limitation "terminal device" to have the meaning "a remote device."

G. "receiving module"

85. In my opinion, this term is governed by §112(f). Although the limitation does not use the term "means for," it is my opinion that a POSITA, considering the claims, specification, and file history, would consider the term "receiving module" not to be a term used by persons of skill in the art to designate either a particular structure or a class of structures. While a person of ordinary skill is familiar with the use of software, codes, or algorithms for manipulation of information, a "receiving module" does not invoke a class of structures, and is not understood by a POSITA to refer to a class of structures. Thus, the term "module" is a nonce term, and a POSITA would have understood the "receiving module" has a function of receiving and a corresponding structure of "receiving module 52" and equivalents thereof. APPLE-1001, 5:43-36, 5:51-53, 10:63-64, 11:6-9.

86. The specification consistently describes the receiving module in functional terms: "The terminal device can be comprised of a receiving module" and "[t]he receiving module in communication with the server receives the

command." APPLE-1001, 5:43-52; *see also id.*, 10:63-64 ("the terminal device 50 can have a receiving module 52"), 11:6-9 ("The method includes transmitting the command to the receiving module 52 of terminal device 50 with the output module 48 of the server 40."). Although the receiving module is associated in the '738 patent specification with reference number 52, the receiving module is not illustrated in the figures.

87. As I explain below, there is significant overlap between the '738 patent's claimed function of the receiving module and the teachings in the cited prior art.

H. "means for initiating activity of said terminal device corresponding to said command"

88. In my opinion, this term is governed by §112(f). The limitation uses the term "means for" and is recited in terms of its function ("initiating activity of said terminal device corresponding to said command") instead of its structure. I understand that when a term recites "means for" there is a rebuttable presumption that the claim is governed by §112(f). In this case, the presumption is appropriate.

89. The specification describes the function and corresponding structure of the "means for initiating activity": "The terminal device can be comprised of a receiving module and means for initiating activity of the terminal device corresponding to the command" and "the means for initiating performs the activity" associated with a command received by the receiving module. APPLE-

1001, 5:43-53. The '738 patent explains that "[t]he means for initiating can be a switch or other actuating mechanism to change the status of the terminal device." *Id.*, 5:53-55.

90. Apple's construction of the term "means for initiating activity of said terminal device corresponding to said command" under §112(f) is consistent with the treatment of the term during the prosecution of the '738 patent. During prosecution, the Examiner issued a statement explaining that the claim element "means for initiating activity of said terminal device" was being interpreted under 35 U.S.C. §112(f) and stated that the corresponding structure was understood to be "the switch or other actuating mechanism to change the status of the terminal device" based on the disclosure in the application as filed. APPLE-1002, 100-102. The applicant responded stating:

> The means + function format is confirmed. Paragraphs 30 and 50 recite the switch and corresponding means for initiating activity of the terminal device.

Id., 141. The construction offered by APPLE is consistent with the applicant's stated intent for " means for initiating activity of said terminal device corresponding to said command" to invoke §112(f) and to have a corresponding structure of "switch or other actuating mechanism that changes the status of a terminal device" and equivalents thereof. *Id.*

91. Based on the ’738 patent’s disclosure and the applicant’s statements in the prosecution history, a POSITA would have understood the corresponding structure for the recited “means for initiating activity” encompasses “switches” and equivalents thereof. For the purposes of comparing claims 1 and 10 to the prior art grounds, a component of a terminal device comprising a “switch” for initiating activity of the terminal device and its equivalents provides the corresponding structure for the claimed “means for initiating activity” limitation. As I explain below, there is significant overlap between the ’738 patent’s claimed function of the means for initiating activity and the teachings in the cited prior art.

IX. APPLICATION OF PRIOR ART TO THE CHALLENGED CLAIMS

92. The claims of the ’738 patent are invalid under either of Apple’s Constructions or Haptic’s Constructions (described above). In particular, the claims are challenged under two theories.

93. **Grounds 1A-1C:** The first theory applies Murakoshi and Stewart, and maps each of the limitations of the challenged claims to these references. Murakoshi (as I will further describe below) describes a system much like the “manual control system” of the ’738 patent (APPLE-1001, 1:40). In Murakoshi’s system, as in the ’738 patent, a device containing an accelerometer is placed on a surface to allow a user’s interactions with the surface (e.g., taps and scratches) to be used to control external devices and appliances. APPLE-1004, [0013]. Like the

’738 patent, Murakoshi’s “apparatus may convert each of the generated one or more vibratory signals [from the user interaction with the surface] into vibratory signal components” and the components are “indicative of an operation associated with [a particular] device.” *Id.*, [0014]-[0015]. Stewart provides additional details related to structures for fixing an accelerometer within a casing and for fixing the accelerometer casing to a surface on which vibrations are to be measured. Sachs and Orr also provide additional details related to processing method and location as I will discuss below.

94. **In Ground 1A,** I explain that the Challenged Claims are obvious over Murakoshi and Stewart under Haptic’s apparent understandings of the claims terms based on both their infringement contentions as well as the Joint Claim Construction statement. *See* APPLE-1101; APPLE-1107. Murakoshi discloses an apparatus containing a sensor for detecting taps on a vibratory surface to which the apparatus is mounted, and further discloses processing the detected taps to determine an intended user command to control a device. As I will explain in detail below, a POSITA would have found it obvious to implement Murakoshi’s system with Stewart’s teaching to position an accelerometer within a housing and attach the housing to a surface.

95. **In Ground 1B,** I explain that, under Haptic’s apparent understandings of the claims terms based on both their infringement contentions as well as the

Joint Claim Construction statement, the Challenged Claims are obvious over Murakoshi and Stewart in view of Sachs. *See* APPLE-1101; APPLE-1107. A POSITA would have been further motivated to combine Sachs with Murakoshi-Stewart because Sachs provides additional details about how to process vibration data from an accelerometer to match a pattern of impacts to a command.

96. **In Ground 1C,** I explain that, under Apple's proposed constructions, the Challenged Claims are obvious over Murakoshi in view of Stewart, Sachs and Orr. As I will explain below, it was well known by the Critical Date to utilize a server for processing data, and a POSITA would have been motivated to combine Orr with Murakoshi-Stewart-Sachs in view of Orr's teaching to utilize a server for offloading the processing of user input signals.

97. **Grounds 2A-2B:** The second theory follows Haptic's mapping of the claim limitations to structures of an iPhone as Haptic presents in their infringement contentions. APPLE-1101. I do not opine on whether this mapping is fully consistent with the details of the specification and prosecution history, but instead I explain this mapping below to illustrate that, even if the claims are understood to be broad enough to encompass Haptic's apparent understanding of the claim terms, the claims are still invalid under the prior art.

98. In particular, the second theory applies Li, which discloses a gesture detector positioned within an iPhone for detecting user taps on the back of the

phone to control phone applications, in combination with iFixit which provides additional detail regarding the structures and components of the iPhone. Sachs provides additional details related to the processing of detected user taps. Under Haptic's expected constructions, the challenged claims are invalid over Li and iFixit, and Li and iFixit in view of Sachs.

99. **In Ground 2A,** under Haptic's apparent understandings of the claim terms based on the infringement contentions and Joint Claim Construction statement, the Challenged Claims are obvious over Li in view of iFixit. *See* APPLE-1101; APPLE-1107. As will be explained below, Li discloses a method for detecting user gestures on a back side of an iPhone and controlling components and applications of the iPhone based on the detected gestures. A POSITA would have been motivated to look to iFixit to understand where an iPhone's accelerometer was positioned within the phone and would have been motivated to incorporate iFixit's teachings with Li's teachings to make use of the already present sensor to detect user taps on an iPhone.

100. **In Ground 2B,** under Haptic's apparent understandings of the claim terms, the Challenged Claims are obvious over Li and iFixit in further view of Sachs. A POSITA would have been motivated to combine Sachs with Li-iFixit because Sachs describes additional details related to processing of vibration data from an accelerometer for matching a tap pattern to a command.

101. Below I will explain each of the grounds fully. The grounds – and the claim construction or apparent understanding of the claim terms under which each ground is mapped –are summarized in this table for ease of reference:

Ground	Claims	Basis	Claim Construction / Understanding
1A	1-2, 8-10	§103 – Murakoshi, Stewart	Haptic's
1B	1-2, 4-5, 9-11	§103 – Murakoshi, Stewart, Sachs	Haptic's
1C	1-2, 4-5, 8-11	§103 – Murakoshi, Stewart, Sachs, Orr	Apple's
2A	1-2, 8-10	§103 – Li, iFixit	Haptic's
2B	4-5, 11	§103 – Li, iFixit, Sachs	Haptic's

102. As I understand, each reference relied on in the above grounds pre-dates the Critical Date of the '738 patent and qualifies as prior art based on its filing date and/or publication date according to the below table.

Reference	Filing Date	Publication Date	Prior Art Under
Murakoshi (APPLE-1004)	1/8/2013	7/10/2014	§102(a)-(b)
Orr (APPLE-1005)	9/30/2014	12/3/2015	§102(b)
Stewart (APPLE-1006)	7/10/1986	5/17/1988	§102(a—-(b)
Li (APPLE-1008)	11/2/2013	11/2/2013	§102(b)
iFixit (APPLE-1010)	-	9/19/2014	§102(a—-(b)
Sachs (APPLE-1007)	10/15/2008	10/22/2009	§102(a—-(b)

A. GROUND 1A: THE MURAKOSHI-STEWART COMBINATION RENDERS CLAIMS 1-2, 4-5, AND 8-10 OBVIOUS

103. Discussion below covers Ground 1A under Haptic's apparent understanding of the claim terms. In the below discussion, I refer to Haptic's infringement contentions (APPLE-1101), as well as to the claim construction section above when necessary to explain Haptic's apparent understanding of certain claim terms.

1. Overview of Murakoshi (APPLE-1004)

104. Murakoshi is directed to "controlling a user interface of a device [comprising] one or more sensors coupled to a vibratory surface associated with the apparatus." APPLE-1004, Abstract, [0018], [0034]. Murakoshi's system, illustrated in Fig. 1, includes "a device 102, an apparatus 104 for controlling a user interface of the device 102, a vibratory surface 106 associated with the apparatus 104, and an object 108 for interacting with the vibratory surface 106." *Id.*, [0016], [0017] ("[t]he device 102 may correspond to a machine that may be operated by a user" such as lamps or "mobile phones, laptops, tablet computers, televisions, Personal Digital Assistant (PDA) devices, vehicles, home appliances, media playing devices, and/or any other device operable by a user"), [0064] (describing a lamp), [0084] (same). "The apparatus 104 may be coupled to the vibratory surface 106." *Id.*, [0021]. Murakoshi describes that the interaction between the object and

the vibratory surface can be "scratching or tapping on the vibratory surface 106 using the object 108." *Id.*, [0022].

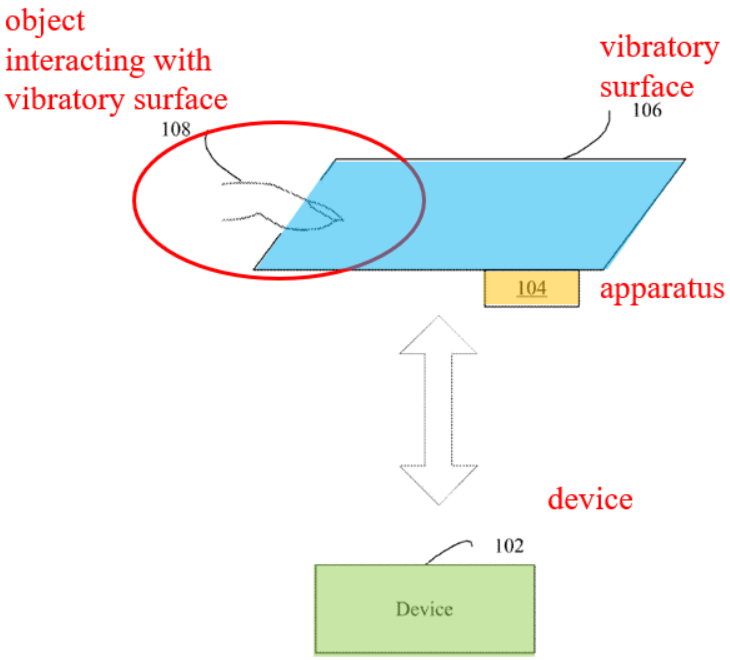


FIG. 1

APPLE-1004, Fig. 1 (annotated)

105. Murakoshi's Fig. 2 illustrates that "[t]he apparatus 104 may comprise one or more processors, such as a processor 202, a memory 204, one or more sensors, such as sensor 206, an analog to digital converter 208…, a receiver 210, and a transmitter 212." *Id.*, [0025]. Murakoshi's sensor is configured "to detect one or more vibrations of the vibratory surface 106 … caused by an interaction of the object 108 with the vibratory surface 106." *Id.*, [0029]. The sensor (an

accelerometer) then "generate[s] one or more vibratory signals in response to the detected one or more vibrations." *Id.*

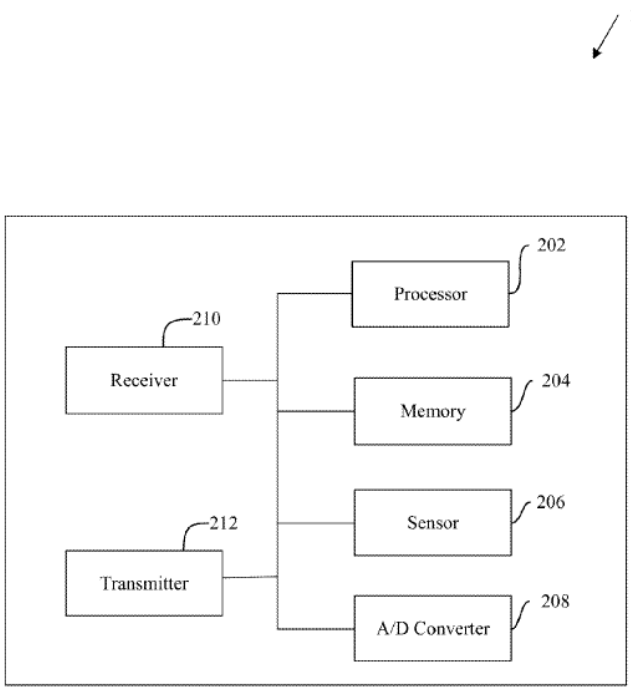


FIG. 2

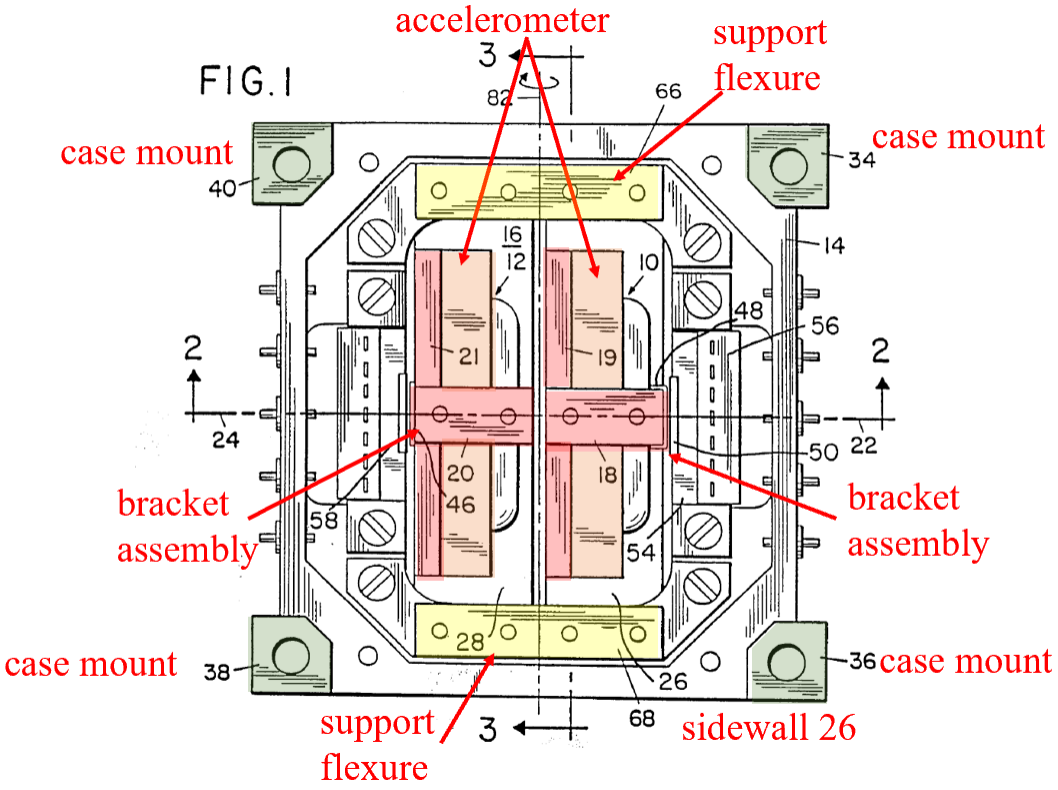
APPLE-1004, Fig. 2

106. In use, receiver 210 "may receive the vibratory signal generated by the sensor 206 external to the apparatus 104." *Id.*, [0031]. The transmitter 212 "may transmit a control signal to control the user interface of the device 102." *Id.*, [0033]. The processor 202 "may be operable to convert each of the generated one or more vibratory signals into vibratory signal components," and "may generate a

control signal that corresponds to the generated one or more vibratory signals to control the user interface of the device 102." *Id.*, [0038], [0036]. The processor identifies a gesture associated with the vibratory signals and "may generate a control signal that corresponds to the determined gesture." *Id.*, [0050]; *see also generally*, *id.*, [0048]-[0050]. "The processor 202 may communicate the generated control signal to the device 102 via the transmitter 212." *Id.*, [0048].

2. Overview of Stewart (APPLE-1006)

107. Stewart is directed to "a vibrating multisensor." APPLE-1006, Abstract. Stewart describes that, in the vibrating multisensor, "[t]he accelerometers are preferably of a force balance type in which an inertial mass member is positioned and suspended to react to and to provide a signal that is a measure of acceleration of the supporting structure along a predetermined axis." *Id.*, 4:64-68. Stewart's "accelerometers are positioned within a cavity 16 within the case 14." *Id.*, 5:8-9. The case, or casing, is bounded by sidewalls 26, as illustrated below in Fig. 1. *Id.*, Fig. 1.



APPLE-1006, Fig. 1 (annotated)

108. "Accelerometer 10 is attached to a three-part bracket assembly that includes the finger 18 and the beam 19 [and] [a]ccelerometer 12 is attached to a three-part bracket assembly that includes finger 20 and beam 21." *Id.*, 5:9-13. "[E]ach combined bracket-and-accelerometer assembly is sandwiched between a pair of spaced-apart flexible sidebeams." *Id.*, 5:16-18. "The mass members of the right and left assemblies of accelerometers, brackets and sidebeam pairs are substantially identical to reduce loads at the case mounts 34, 36, 38 and 40." *Id.*, 5:34-37. As illustrated above in Fig. 1, the case mounts 34, 36, 38, and 40 are

positioned at the corners of the casing and are formed as a tab with an aperture. *See id.*, Fig. 1.

3. The Murakoshi-Stewart Combination

a) The Combination

109. In the Murakoshi-Stewart combination ("Murakoshi-Stewart"), Murakoshi's teaching to position an accelerometer within an apparatus, and to fix the apparatus to a vibratory surface is implemented with Stewart's teachings to mount an accelerometer within a case using brackets and sidebeams, and to couple the case to a surface using case mounts and mounting fasteners. APPLE-1004, [0021], [0029]-[0030]; APPLE-1006, 5:8-9, 5:34-37, Fig. 1. I note that the combination of Murakoshi and Stewart is proposed as a combination of the teachings of the two references, and does not require bodily incorporation or physical integration of Stewart's device into any apparatus of Murakoshi.

110. Murakoshi describes that the "sensor 206 may include … an accelerometer … and/or any sensor operable to detect vibrations of the vibratory surface 106 and generate vibratory signals in response to the detected vibrations." APPLE-1004, [0029]. Additionally, Murakoshi describes that "the sensor 206 may be an integral part of the apparatus 104" and that the apparatus is "coupled to" or "fixed on" the vibratory surface. *Id*., [0030], [021]. However, Murakoshi does

not explicitly describe the precise methods of how to mount the accelerometer within the apparatus or how to mount the apparatus to the surface.

111. The process of mounting a sensor within a housing and fixing a housing to a surface, was within the common knowledge of a POSITA by the Critical Date, including the use of brackets to hold a sensor in place and fasteners to couple a housing to a surface. *See supra* §VI.B.3. At the time of the patent, brackets were (and still are today) a common method for securely attaching sensors within a housing. Typically, a screw or other fastener is positioned to extend through a mounting hole in the bracket and into a receiving hole in the sensor (or casing attached to the sensor). Fasteners such as bolts, nails, magnets, adhesives, mounting brackets, studs and screws are, and were at the time of the patent, used to mount the housing of accelerometers to the surfaces on which the accelerometer was intended to sense vibrations. APPLE-1039, 1; APPLE-1049, [0028]; APPLE-1048, [0082], [0059]. Typically, a screw would go through a mounting hole formed in the housing and screw directly into the surface to securely fasten the housing to the surface.

112. To the extent that methods of securing an accelerometer within a housing and attaching the housing to a surface would not have been within the common knowledge by the Critical Date, to find out additional details about how to position an accelerometer within Murakoshi's apparatus and how to mount the

apparatus to the vibratory surface, a POSITA would have looked to accelerometer references such as Stewart, which discloses that the "accelerometers are positioned … within the case 14" using brackets and that the case includes case mounts at the corners. APPLE-1006, 5:8-9, 5:34-37, Fig. 1. A POSITA would have looked at references such as Stewart (that disclose straightforward mounting techniques) to position an accelerometer within Murakoshi's apparatus because proper accelerometer mounting is important for accelerometer performance. *See* APPLE-1037, 3, 4; APPLE-1039, 1; APPLE-1040, 7. The brackets and corner case mounts disclosed in Stewart would ensure accurate accelerometer performance because surface vibrations can be transferred through the housing and bracket to the sensor without loss of data due to mechanical play between the housing/surface and sensor/bracket/housing. *See* APPLE-1041, 25-32; APPLE-1046, [0013] ("Accelerometers 20 are disposed in area 4 with a physical connection to one or more solid surfaces 6 to allow vibrations to transmit from the surfaces 6 tapped by users 2 to the surfaces 6 in physical contact with accelerometers 20 [such that] vibrations transmit though any solid materials of area 4 between the tapped surfaces 6 and the surfaces in physical contact with accelerometers 20.").

113. A POSITA would have understood from Stewart's disclosure that the case mounts are meant to mount the case using a fastener that extends through the hole in the case mount and into a desired surface. For accurate measurement of

vibration with the accelerometer, a common fastener such as a screw or stud mount would have been (and still would be today) inserted through the case mount hole and into the desired surface. *See* APPLE-1039, 1, 2. This ensures that the surface vibrations also vibrate the accelerometer in the case or housing, and that the vibrations would not be dampened or attenuated by play between the surface and the housing. *See* APPLE-1037, 3, 4; APPLE-1039, 1; APPLE-1040, 7. Thus, it would have been obvious in view of Stewart's teachings to implement Murakoshi's system with Murakoshi's accelerometer held in place within the apparatus using brackets and with case mounts for use with fasteners to affix the apparatus to a vibratory surface, as Stewart teaches. As described above, using brackets and fasteners to mount the sensor within the housing and housing to a surface would have been well-known to the POSITA by the Critical Date, but to the extent that it was not, a POSITA would have understood from Stewart details of common implementation methods that supplement Murakoshi's teaching to provide an apparatus capable of "detect[ing] vibrations of the vibratory surface." APPLE-1004, [0029].

b) Reasons for the Combination

114. A POSITA, motivated to combine Murakoshi and Stewart, would have done so by attaching Murakoshi's accelerometer within a casing of the apparatus using brackets and sidebeams. APPLE-1006, 5:8-18. Accelerometers

need to be firmly attached within a casing, for example as Stewart teaches, to operate effectively, because vibrations external to the casing need to be passed through the casing to the accelerometer, and the accelerometer needs to be able to move relative to the casing (and relative to the surface the casing is mounted to) to detect the extent of the vibrations. *See* APPLE-1041, 28-30; APPLE-1037, 3, 4.

115. As I described above, brackets and sidebeams, such as those disclosed in Stewart were (and still are) effective and common methods of affixing objects, including accelerometers, within a case by the Critical Date. A POSITA would have further implemented Stewart's teachings to include case mounts on the casing of Murakoshi's apparatus to affix the apparatus to the vibratory surface using fasteners. APPLE-1004, [0021]; APPLE-1006, 5:34-37. An accelerometer's casing or housing needs to be firmly attached to the vibratory surface to effectively transmit the vibration signal through to the accelerometer sensor. *See* APPLE-1039, 1, 2. Using fasteners, such as screws, in combination with an accelerometer's case mounts, such as those in Stewart, was (and still is) an effective method to affix an accelerometer's case mounts to a vibratory surface.

116. A POSITA would have been motivated to pursue the Murakoshi-Stewart combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

117. First, a POSITA would have understood that Murakoshi's accelerometer must be fixed within the apparatus by some mechanism to orient the accelerometer within the housing and to prevent the accelerometer from moving around within the housing. *See supra,* §VI.B.3. The appropriate function of an accelerometer requires that the movement of the sensor is tied to the movement of the vibratory surface. *See* APPLE-1041, 28-30; APPLE-1037, 3, 4. Accelerometer movement independent of the vibratory surface or device or measurement would result in an improper acceleration or vibration measurement. *See* APPLE-1041, 28-30; APPLE-1037, 3, 4. An accelerometer's orientation (i.e., how it is positioned relative to the direction of the vibration or motion) also determines whether it reports proper measurement values. APPLE-1038, 2-4. Thus, an accelerometer that is not fixed within its housing or apparatus would report incorrect measurement values and fail to function correctly.

118. Fixing the accelerometer within the housing would prevent the accelerometer from being loose within the housing, moving around and possibly being damaged. For example, a loose accelerometer could slide from its initial position and collide with other components or surfaces, damaging the sensor. Murakoshi's description that the sensor is "integral" to the apparatus would have motivated a POSITA to investigate ways to fix the accelerometer within a device and would have looked to other accelerometer references such as Stewart.

APPLE-1004, [0030]. A POSITA would have recognized that the brackets and sidebeams described in Stewart fix the accelerometer in position within the casing, and still allow the accelerometer to detect vibrations, as Murakoshi directs. APPLE-1004, [0029].

119. Second, a POSITA would have been motivated to mount the accelerometer within a housing using support flexures, brackets and side beams and to mount the housing to a surface using case mounts (as Stewart teaches) to enable the accelerometer to effectively detect vibrations without interference from housing components. APPLE-1004, [0021]; APPLE-1006, 7:61-64. Stewart describes that "[t]he accelerometers are suspended within the case of the multisensor to minimize any deleterious mechanical feedback between the accelerometer and case.". APPLE-1006, 7:61-64. A POSITA would have understood from Stewart's disclosure that structures like brackets and sidebeams hold an accelerometer within a casing so that vibrations can be efficiently passed to the accelerometer for measuring/detecting instead of being attenuated by mechanical play between the casing and the sensor. When the vibrations are not attenuated, the accelerometer can accurately detect the full range of the vibration and report the same.

120. Third, a POSITA would have understood that there are multiple known mechanisms for coupling an apparatus to a surface, as Murakoshi directs,

and would have been capable of selecting between the known possibilities. *See supra*, §VI.B.3; APPLE-1004, [0021]. It was well known by the Critical Date that accelerometers could be, among other methods, stud mounted, adhesively bonded, magnetically mounted, or mounted with pre-drilled holes. APPLE-1039, 1, 2; APPLE-1049, [0028], APPLE-1048, [0082]. Additionally, various types of fasteners such as screws, bolts, mounting pads, fin mounts, and mounting studs were (and still are today) used to couple an apparatus to a surface. *See id.* A POSITA would have understood Stewart's description of "case mounts" to be one such option – that is, using pre-drilled mounting holes in a casing to mount the casing to a surface with a fastener, such as a bolt. APPLE-1006, 5:36 ("case mounts"). At the time of the patent (and today), case mounts commonly used pre-drilled holes and fasteners for purposes of connecting an apparatus to a surface.

121. A POSITA would have understood that there are a variety of suitable options for attaching a sensor housing to a surface. A POSITA would have recognized that Stewart's teaching to incorporate case mounts into a housing of an accelerometer for ease of attachment to a surface using conventional fasteners would be a suitable option for securing an apparatus containing an accelerometer to Murakoshi's vibratory surface because doing so would accomplish Murakoshi's directive to fix the apparatus to the surface and would allow the accelerometer to detect vibrations without attenuation of signal due to loose connections between

the housing and surface, as described above. *Supra* §VI.B.3. Fasteners, such as bolts and screws, have long been used to affix cases and various apparatuses, including accelerometer apparatuses, to surfaces because of their low cost and ease-of-use. It was known at the time of the patent that fasteners provide a secure and tight connection between two objects, making them suitable for use with accelerometers.

122. Fourth, A POSITA would have recognized that, out of the known possible mechanisms for affixing an accelerometer within a housing, Stewart's teaching of using brackets and sidebeams is a suitable option that could be used in the context of Murakoshi's apparatus. Brackets and sidebeams are suitable mechanisms for attaching an accelerometer to a housing because they solidly fix the two together and allow vibrations on the housing to transmit to the accelerometer. A POSITA would have appreciated that putting a fastener, such as a screw, through a hole in the bracket and screwing it into the accelerometer would prevent or reduce unwanted movement of the accelerometer within the casing.

123. Fifth, a POSITA would have understood that implementing Stewart's teachings to position the accelerometer within a casing of the apparatus using brackets and sidebeams and to fix the casing to the vibratory surface with case mounts and fasteners in the context of Murakoshi's tap-input apparatus would have yielded predictable results from combining known elements according to known

methods. Threading fasteners, such as screws, through a bracket (as disclosed in Stewart) and into an accelerometer, such as the one described in Murakoshi, predictably fixes the accelerometer to the bracket. Similarly, threading fasteners, such as screws, through an apparatus' mounting holes, such as the ones in Stewart, and into a surface, predictably fixes the apparatus, such as the one in Murakoshi, to the surface.

124. Additionally, a POSITA would have appreciated that both Murakoshi and Stewart describe an apparatus that includes an accelerometer for detecting vibrations. APPLE-1004, [0029]; APPLE-1006, Abstract, 5:54-61. Because both references are related to detection of vibrations using an accelerometer, a POSITA would have understood that the teachings of the references could be combined and would have had a reasonable expectation of success in making the combination. In the combination, each element performs a similar function as it does in the reference. In particular, because the combination relies on the combination of the teachings of the references rather than any bodily incorporation, a POSITA would have understood that brackets for coupling an accelerometer within a casing, as Stewart teaches, could be implemented within an apparatus, per Murakoshi, to hold an accelerometer within the casing of the apparatus. The teaching of brackets, as applied to Murakoshi's teaching of an apparatus containing an accelerometer,

perform the same function in the apparatus as they do in Stewart – holding the accelerometer in place while allowing the accelerometer to detect vibrations.

125. This use of brackets and sidebeams to position Murakoshi's accelerometer within a casing of the apparatus and use of case mounts and fasteners to fix the casing to Murakoshi's vibratory surface would have been well within a POSITA's skill level. Positioning and securing an accelerometer within a casing and securing the casing to the vibratory surface is fundamental to having a successful measurement system. *See* APPLE-1037, 2-3, APPLE-1041, 25-29. Indeed, a POSITA would have been readily able to position an accelerometer within Murakoshi-Stewart's apparatus and fix the apparatus to the vibratory surface with case mounts and fasteners as Stewart describes. Positioning and fixing an accelerometer within an apparatus is a routine part of using accelerometers. *See* APPLE-1037, 2-3, APPLE-1041, 25-29; APPLE-1038, 2-4. Indeed, the operation of an accelerometer depends on the fixation of the accelerometer relative to the surface to be detected. *See* APPLE-1037, 2-3, APPLE-1041, 25-29; APPLE-1038, 2-4. Similarly, an accelerometer must be properly secured to the vibratory surface in order for it to perform optimally. *See* APPLE-1039, 1, 2. The use of case mounts and fasteners, as described in Stewart, to secure the apparatus to the vibratory surface would have been straightforward for a POSITA because it simply required screwing the apparatus into the surface,

further illustrating that a POSITA would have had a reasonable expectation of success in combining these teachings of Murakoshi and Stewart. In the same way, it would have been straightforward for a POSITA to position the accelerometer within the Murakoshi-Stewart apparatus by screwing the bracket into the accelerometer, additionally showing that a POSITA would have had a reasonable expectation of success in the combination. Applying and combining these concepts would have been obvious from a POSITA's perspective, and a POSITA would have had a reasonable expectation of success in doing so for all of the above reasons.

4. Element-by-Element Analysis

c) Claim 1

[1pre] A control system comprising:

126. To the extent that the preamble is limiting, Murakoshi discloses it. For example, Murakoshi discloses "an apparatus and method ***for controlling*** a user interface of a device." APPLE-1004, [0002] (emphasis added), [0005], [0013] ("The apparatus may generate a control signal corresponding to the one or more generated vibratory signals to control the user interface of the device."). Murakoshi describes that "FIG. 1 is a block diagram illustrating controlling a user interface of a device based on vibratory input, in accordance with an embodiment of the disclosure." *Id*., [0016]. Fig. 1 (reproduced below) illustrates "a device 102,

an apparatus 104 for controlling a user interface of the device 102, a vibratory surface 106 associated with the apparatus 104, and an object 108 for interacting with the vibratory surface 106." *Id.* "The apparatus may detect one or more vibrations of a vibratory surface caused by an interaction of an object with the vibratory surface." *Id.*, [0013].

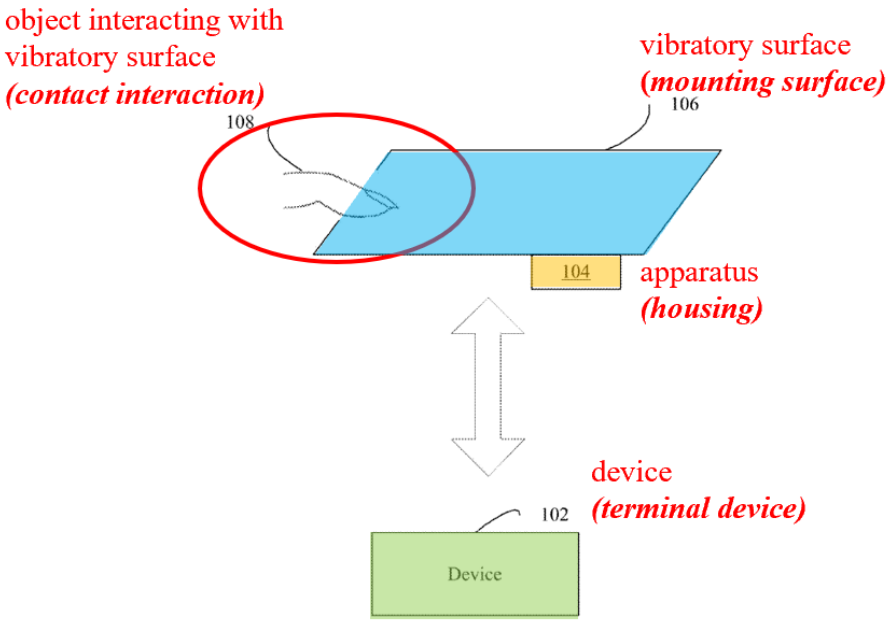


FIG. 1

APPLE-1004, Fig. 1 (annotated)

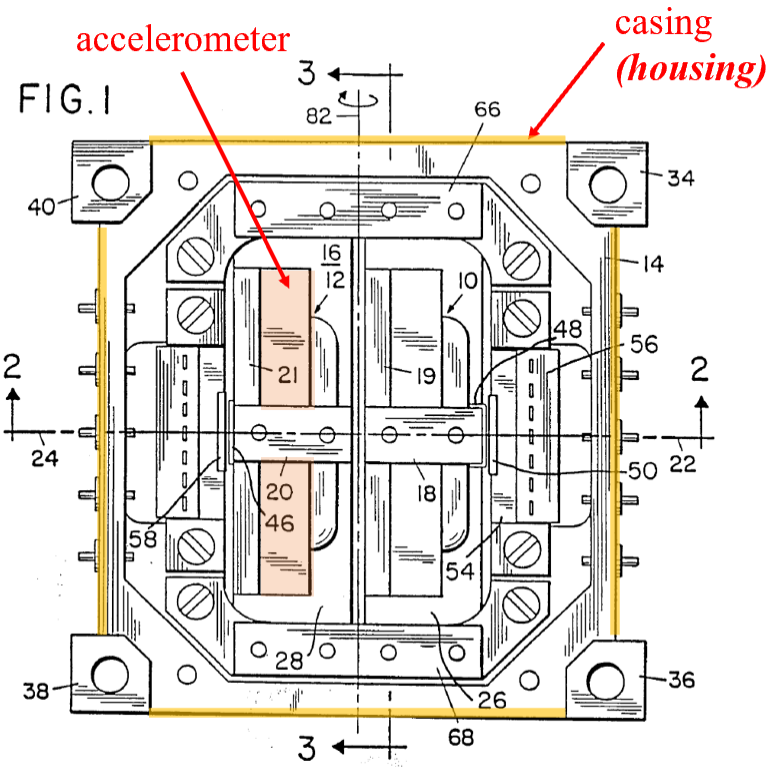
127. In Murakoshi's system, "[t]he apparatus may generate one or more vibratory signals in response to the detected one or more vibrations." APPLE-1004, [0013]. "The apparatus may generate a ***control*** signal corresponding to the one or more generated vibratory signals to control the user interface of the device."

Id. (emphasis added). Accordingly, Murakoshi's control system relies on an apparatus "operable to control the user interface of the device 102 based on an interaction of the object 108 with the vibratory surface 106." APPLE-1004, [0018]. Further, "[b]ased on the interaction, a user may control one or more operations of the device 102." *Id.*

128. Additional details of the claimed "control system" of Murakoshi are discussed below with regard to the other limitations of claim 1.

[1a] a housing having an engagement means for a mounting surface;

129. As described above, in Murakoshi-Stewart, an apparatus, per Murakoshi, is implemented with the teachings of Stewart to position the accelerometer within a casing (housing). APPLE-1006, 5:8-9, Fig. 1. In the combination, Stewart's teaching of a casing provides a housing for the accelerometer.



APPLE-1006, Fig. 1 (annotated)

130. Murakoshi discloses an apparatus mounted to a vibratory surface (mounting surface). APPLE-1004, [0021]. Murakoshi discloses that "[t]he apparatus 104 may be fixed above and/or below the table top." *Id.*, [0021]. In Murakoshi's Figure 1, below, the apparatus 104 (orange) is fixed below the vibratory surface 106 (blue). Nevertheless, the apparatus 104 may be above the vibratory surface 106 in other embodiments. *See id.*, [0021].

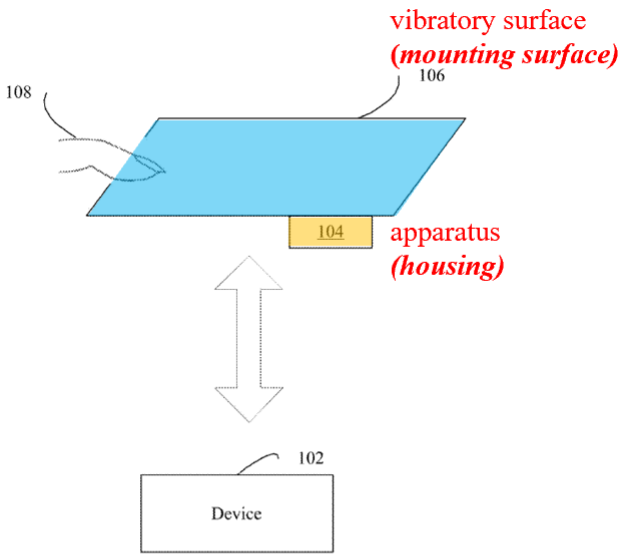


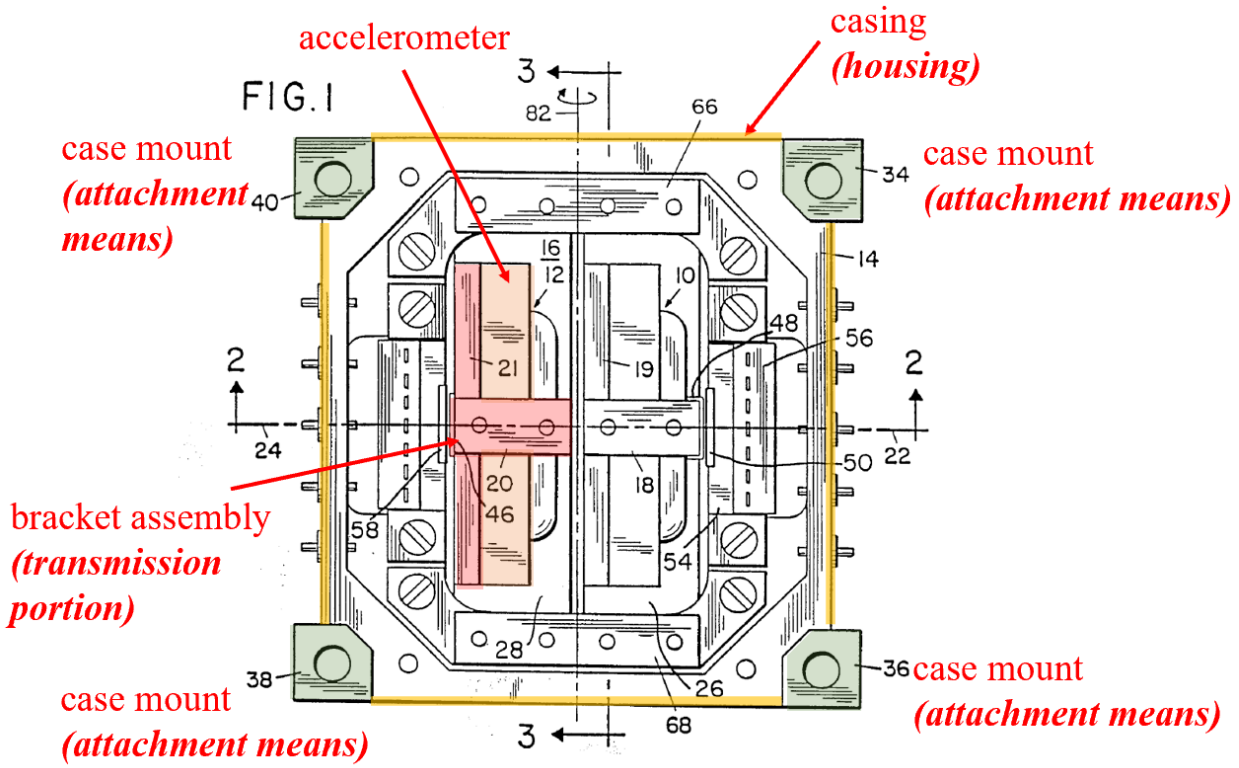
FIG. 1

APPLE-1004, Fig. 1 (annotated)

131. Applying Haptic's apparent understanding of the claim term,[6] Murakoshi-Stewart renders obvious an "engagement means" because it includes case mounts for use with mechanical fasteners to attach the case to a surface (i.e., attachment means) and a three-part bracket assembly to connect the accelerometer

[6] As described above, Haptic's apparent understanding of the claim terms ("Haptic's apparent understanding") is based on Haptic's interpretations of claim limitations presented in preliminary infringement contentions and the Joint Claim Construction statement. *See generally* APPLE-1101; APPLE-1107.

to the case (i.e., a transmission portion), per Stewart. A detailed §112(f) analysis for the "engagement means" element is provided below in Element [1e].



APPLE-1006, Fig. 1 (annotated)

[1b-i] a sensor contained within said housing,

132. Murakoshi discloses "[t]he apparatus 104 may comprise … one or more sensors, such as a sensor 206" and that "sensor 206 may include… an accelerometer." APPLE-1004, [0025], [0029], [0013]. Murakoshi's teaching of an accelerometer allows Murakoshi's apparatus to detect vibrations from a contact interaction between an object and the vibratory surface (for example, a tap or scratch on the surface). *Id.*, [0029], [0018].

133. Murakoshi further discloses that "the sensor 206 may be an integral part of the apparatus 104." *Id.*, [0030]; Fig. 2. As described above, Murakoshi-Stewart is implemented with the teachings of Stewart to position the accelerometer (sensor) within a casing (housing). APPLE-1006, 5:8-9, Fig. 1; §IX.A.3 (Murakoshi-Stewart Combination).

[1b-ii] said sensor forming an interactive zone defined by a range of said sensor,

134. Murakoshi discloses that the sensor detects vibrations of a vibratory surface (mounting surface) within "a pre-defined region" (interactive zone). APPLE-1004, [0021], Fig. 1. Murakoshi describes that "a user may ***interact at any location within the pre-defined region*** of the vibratory surface 106 to control the user interface of the device 102." *Id.*, [0034] (emphasis added). Murakoshi describes that "[t]he apparatus may detect one or more vibrations of a vibratory surface caused by an interaction of an object with the vibratory surface." APPLE-1004, [0013], [0016], 0021], Fig. 1. A POSITA would have understood that sensors, such as accelerometers, are only operable within a given range in which they are able to sense vibrations – that is, an accelerometer has some limit on the area in which it is able to accurately sense vibrations. Any interaction between a user and a surface that the accelerometer is intended to measure would need to be within this limit or range.

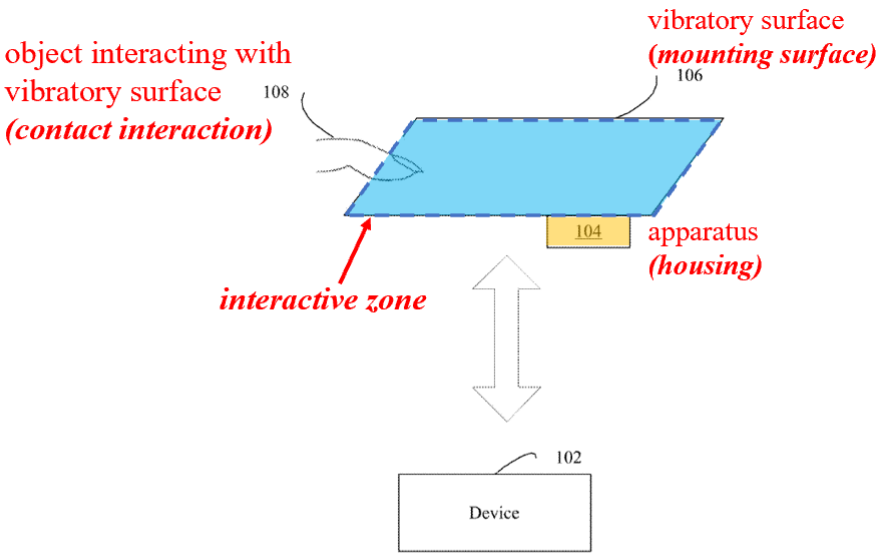


FIG. 1

APPLE-1004, Fig. 1 (annotated)

135. Fig. 1 of Murakoshi depicts an interaction of an object with the vibratory surface (mounting surface, blue) for detection by the sensor in the apparatus (housing, orange). APPLE-1004, [0016], [0021]. A POSITA would have understood from Murakoshi's discussion of its vibratory surface that the pre-defined region of the vibratory surface defines a zone that is within a range of the sensor so that a user's interactions with the surface within the pre-defined zone can be detected by the sensor and used to control device 102.

[1b-iii] said sensor being comprised of an accelerometer,

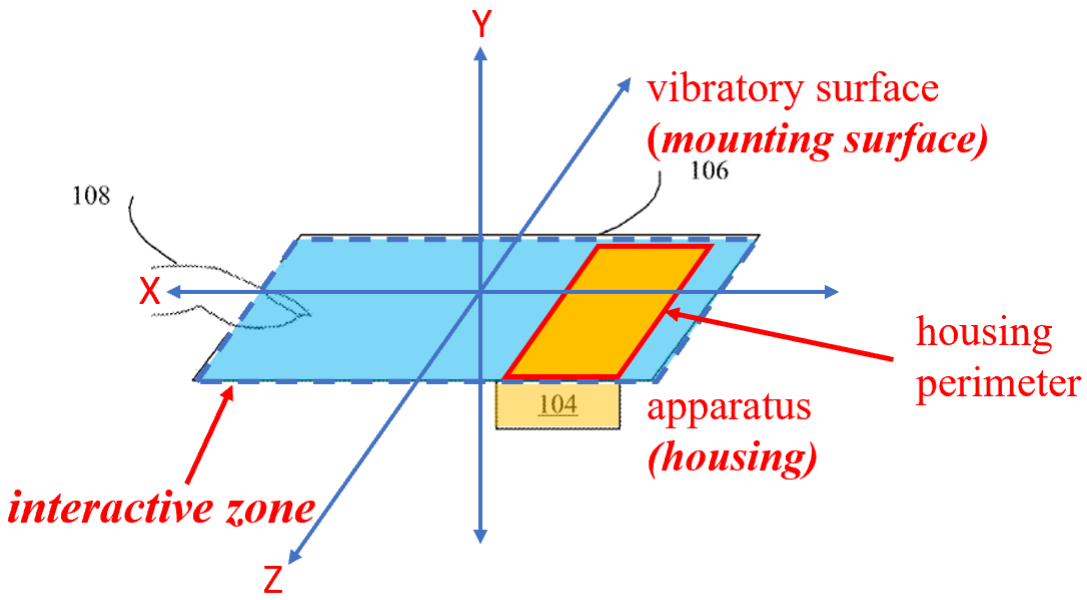
136. Murakoshi discloses that "***sensor 206 may include***… an ***accelerometer***." APPLE-1004, [0029], [0092]. A POSITA would have

understood that an accelerometer is a type of sensor, because it is a device that responds to a physical stimulus (i.e., vibration/acceleration) and transmits a resulting impulse or signal, within the definition of sensor given by Merriam Webster dictionary. APPLE-1054, 1; *see also* APPLE-1055, 1. Additionally, Murakoshi describes that an accelerometer is a suitable type of sensor for use in the apparatus. APPLE-1004, [0029].

[1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing,

137. Under Haptic's apparent understanding of the claim term, a pre-defined region corresponding to the vibratory surface (mounting surface) is aligned with the vibratory surface and overlays the vibratory surface, per Murakoshi, at least because Murakoshi's pre-defined region is formed on the mounting surface. APPLE-1004, [0021], [0029], [0016], [0021], Fig. 1; APPLE-1101, 15-16, 50-51.

138. As illustrated below in Fig. 1, the pre-defined region and the vibratory surface both extend as planes extending in the X-Z directions, and are thus ***aligned***. Two planes are aligned, as shown by the pre-defined region and vibratory surface in Fig. 1, when both planes extend in the same two directions.



APPLE-1004, Fig. 1 (annotated and modified to include axis and housing perimeter)

139. Additionally, Murakoshi's Fig. 1 (above) illustrates that the pre-defined region (interactive zone) overlays the vibratory surface (mounting surface) because the boundaries of the pre-defined region are defined on the vibratory surface. Accordingly, the pre-defined region (interactive zone) extends over a top surface of the vibratory surface and thus overlays the vibratory surface (mounting surface). Finally, the pre-defined region (interactive zone) extends over the vibratory surface (mounting surface) including an area outside the perimeter of the apparatus's housing. APPLE-1004, [0016], Fig. 1. Although the perimeter of the housing is not illustrated in Murakoshi's original figure 1, it is clear from Murakoshi's illustration and disclosure that the vibratory surface extends beyond

the confines of the apparatus, to allow a user to tap or scratch on the vibratory surface and to use the vibratory surface for other purposes. For example, Murakoshi describes that the vibratory surface can be a table top. APPLE-1004, [0020]-[0021], [0023], [0064], [0076]-[0079], Fig. 5.

140. Accordingly, Murakoshi-Stewart render obvious "said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing."

[1b-v] said sensor being in a fixed position relative to said engagement means,

141. As described above, Murakoshi-Stewart renders obvious an "engagement means" at least because it is implemented with case mounts with fasteners to attach an accelerometer housing to a surface ("attachment means") and a bracket assembly for attaching the accelerometer within the housing relative to the case mounts ("transmission portion"), per Stewart. §IX.A.4.[1a]; APPLE-1004, [0021], [0030]; APPLE-1006, 5:8-37; 5:54-651; Fig. 1; §IX.A.3 (Murakoshi-Stewart Combination).

142. A POSITA would have understood that, in Murakoshi-Stewart, an accelerometer (sensor), per Murakoshi, is held in a fixed position within the casing (housing) of the apparatus by a bracket assembly and other structural components that hold the accelerometer (sensor) fixed within the casing (housing) relative to the fasteners that would extend through the case mounts (engagement means).

APPLE-1006, Fig. 1, 5:7-33. Further, as described above, it would have been obvious to a POSITA that it is necessary to hold a sensor in a fixed position relative to a sensing surface to provide a fixed reference point for accurate detection of vibratory signals and processing of those signals in a meaningful way. *Supra* §VI.B.4; §IX.A.3 (Murakoshi-Stewart Combination).

[1b-vi] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals,

143. Regardless of the exact bounds of [1b-vi], Murakoshi-Stewart includes at least the '738 patent's preferred embodiment of this limitation. The '738 patent states that "[w]hen the sensor is an accelerometer, the data signals are vibration data, such as amplitude, intensity, and duration." *Id.*, 5:11-13. The '738 patent further states that "[t]he contact interaction 60 is detected as data signals 70 by the sensor 30 [and t]he data signals 70 are sent from the sensor 30 to the server 30 [to] determine[] a data pattern 80 corresponding to the data signals 70 of the contact interaction 60." APPLE-1001, 10:57-68, *see also* 4:65-66 ("The contact interaction generates the data signals of the sensor through the transmission portion of the housing"), Fig. 2.

144. Like the '738 patent, the accelerometer of Murakoshi-Stewart detects vibrations of the mounting surface (i.e., vibration data). APPLE-1004, [0036] ("the ***sensor 206 may sense vibrations generated in the vibratory surface 106***.") (emphasis added). Murakoshi describes that "***the sensor*** 206 ***may detect one or***

more vibrations of the vibratory surface 106 ***caused by an interaction of the object 108 with the vibratory surface.***" APPLE-1004, [0082] (emphasis added). A POSITA would have expected that accelerometers detect acceleration and vibration data, and would have further understood that data describing vibrations includes data features such as the amplitude, intensity, and duration of the accelerations experienced by the accelerometer. APPLE-1047, [0003] ("When a user taps an object, the object undergoes a rapid acceleration"); APPLE-1046, [0010] ("the term vibration data refers to a set of data values that collectively represent the frequency and amplitude of the vibrations detected by an accelerometer over time").

145. Murakoshi's sensor detects vibrations and produces corresponding vibratory signals that can be transmitted to the server. APPLE-1004, [0029] ("sensor 206 may be operable to generate one or more ***vibratory signals in response to the detected one or more vibrations***") (emphasis added), [0032]. A POSITA would have understood, that, as in the '738 patent, an accelerometer, per Murakoshi, detects signals associated with a vibration on a surface as data signals comprising information about the vibration (i.e., "vibration data").

[1b-vii] said contact interaction being comprised of an impact on said mounting surface,

146. Murakoshi describes the interaction of the object with the vibratory surface (mounting surface) as "a user may scratch and/or ***tap at any location on***

the vibratory surface 106 using the object 108, such as the nail of the finger." *Id.*, [0035], [0022] (emphasis added).

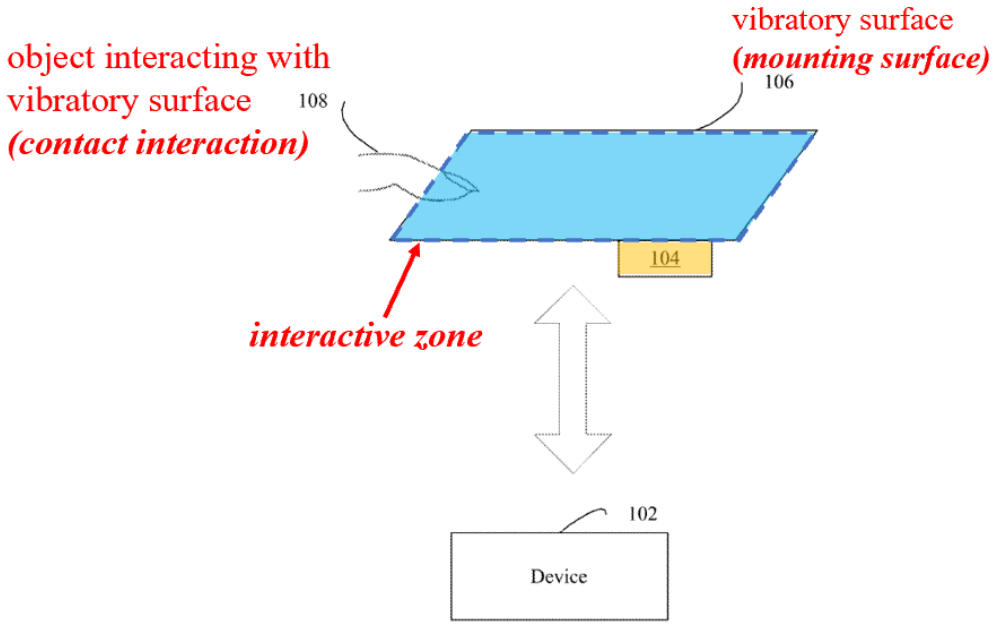


FIG. 1

APPLE-1004, Fig. 1 (annotated) (modified)

147. A POSITA would have recognized Murakoshi's description of a tap on the vibratory surface to be "an impact" on the mounting surface. APPLE-1047 ("A tap is simply a synonym for a light strike, pat or rap that causes an object to undergo acceleration.").

[1b-viii] said data signals being comprised of vibration data of said contact interaction;

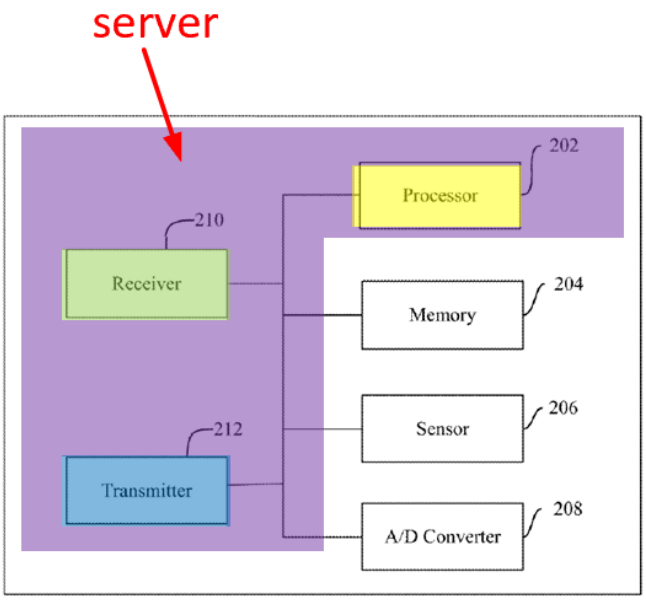
148. As described above, like the '738 patent, Murakoshi-Stewart's accelerometer detects vibrations (data signals) of the vibratory surface associated

with an interaction of an object with the vibratory surface (mounting surface). APPLE-1004, [0082], [0036], [0029], [0032]; APPLE-1001, 10:57-68, Fig. 2; §IX.A.4.[1b-vi]. Murakoshi describes that the accelerometer "may detect one or more ***vibrations*** of the vibratory surface caused by an interaction of an object" with the surface. APPLE-1004, Abstract, [0065]; *see also id.*, [0082], [0084]-[0085]. Murakoshi's description of the detected vibrations is similar to the way the '738 patent describes the data signals: "[w]hen the sensor is an accelerometer, the data signals are vibration data." APPLE-1001, 5:11-12. It would have been obvious to a POSITA that the signals detected by the accelerometer of Murakoshi-Stewart are vibration signals. APPLE-1046, [0010] ("the term vibration data refers to a set of data values that collectively represent the frequency and amplitude of the vibrations detected by an accelerometer over time").

[1c-i] a server in communication with said sensor,

149. Under Haptic's apparent understanding of "server," Murakoshi-Stewart renders obvious "a server in communication with a sensor." APPLE-1101, 20-28, 54-60. Murakoshi-Stewart includes "suitable logic, circuitry, interfaces, and/or code that may be operable to control the user interface of the device 102 based on an interaction of the object 108 with the vibratory surface 106," per Murakoshi. APPLE-1004, [0018]. As illustrated below in Fig. 2, the apparatus includes various components including a processor able to receive the vibratory

signals from the sensor for processing (i.e., in communication with the sensor), a receiver, and a transmitter. APPLE-1004, [0025], Abstract ("One or more processors that are communicatively coupled to the one or more sensors may generate a control signal…"), [0026] ("processor 202 may be communicatively coupled to … sensor 206"), Fig. 2. These components of Murakoshi's apparatus correspond to the claimed components of the server that will be described below.

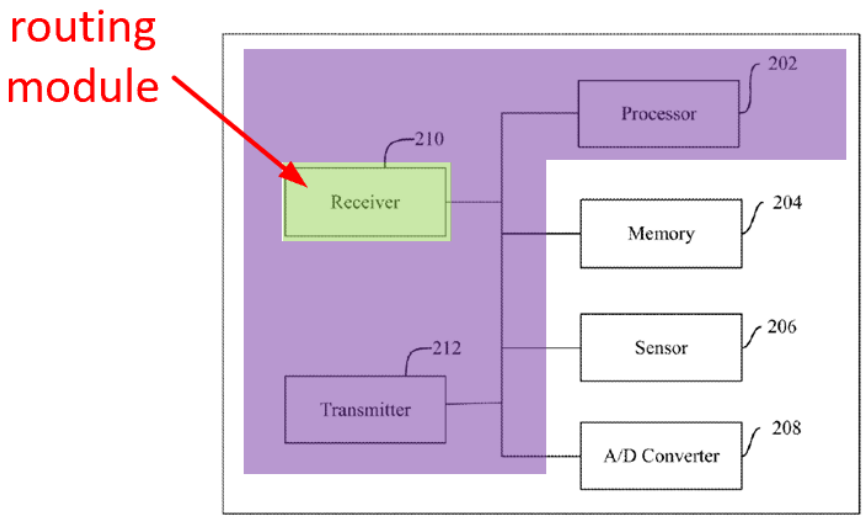


APPLE-1004, Fig. 2 (annotated)

150. A POSITA would have understood that Murakoshi-Stewart includes a "server" under Haptic's apparent understanding of "server"—that is, "suitable logic, circuitry, interfaces, and/or code" associated with components including a processor, receiver, and transmitter, per Murakoshi (described below). APPLE-1101, 20-28, 54-60; APPLE-1004, [0018], [0025].

[1c-ii] said server being comprised of a routing module,

151. Applying Haptic's apparent understanding of the claim element based on the infringement contentions, Murakoshi-Stewart renders obvious a "routing module" (e.g., receiver) that routes and receives data signals from the sensor. §VII (Claim Construction); APPLE-1004, [0032] ("the receiver 210 may receive the vibratory signal generated by the sensor 206"), [0018], [0025]; APPLE-1101, 20-28, 54-60. Murakoshi's receiver 210 is a component of the apparatus and performs the same function as the claimed "routing module" (as I will further explain below with regard to element [1c-v]).

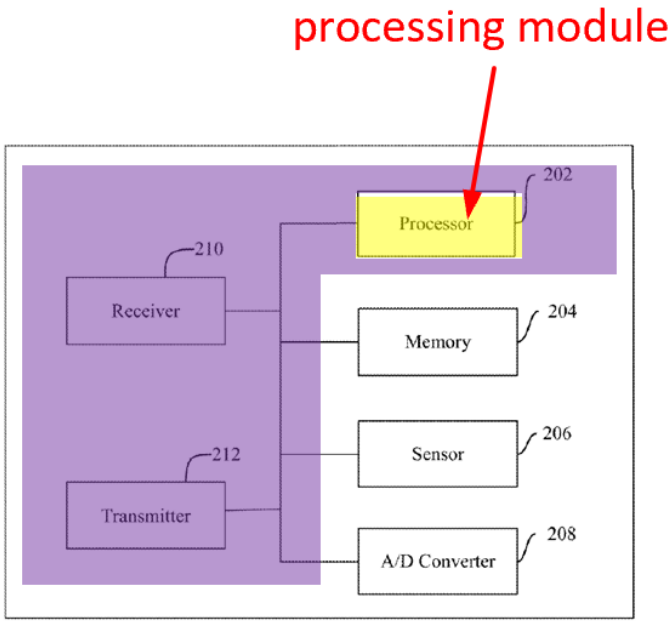


APPLE-1004, Fig. 2 (annotated)

[1c-iii] a processing module being connected to said routing module, and

152. Applying Haptic's apparent understanding of this claim term, Murakoshi-Stewart renders obvious a "processing module" (e.g., processor)

connected to the routing module (e.g., receiver). §VII (Claim Construction); APPLE-1004, [0026] ("the receiver 210 … may be communicatively coupled to the processor 202"), [0013], [0023], ; [0025], [0027], [0036], [0048]; APPLE-1005, [0028]. Murakoshi's processor 202 is a component of the apparatus and performs the same function as the claimed "processing module" (as I will further explain below with regard to element [1c-vi]).

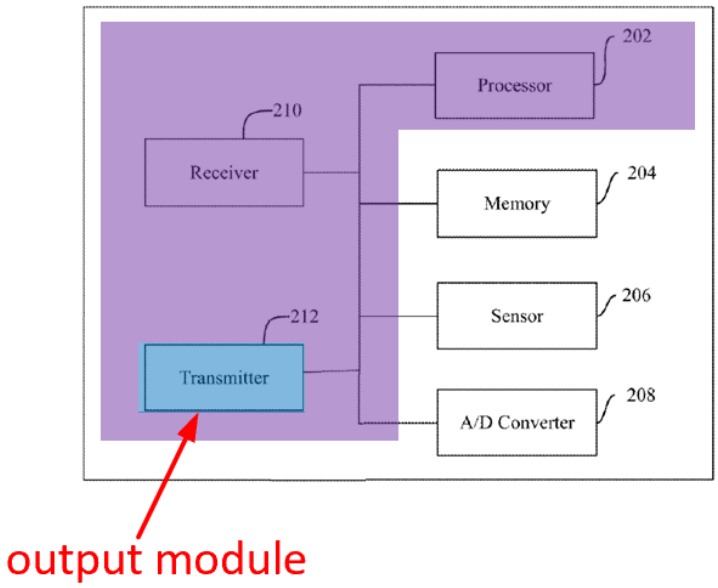


APPLE-1004, Fig. 2 (annotated)

[1c-iv] an output module connected to said processing module,

153. Applying Haptic's apparent understanding of this claim term, Murakoshi-Stewart renders obvious an "output module" (e.g., transmitter) connected to the processing module (e.g., processor). §VIII (Claim Construction); APPLE-1004, [0026] ("the transmitter 212 may be communicatively coupled to the

processor 202"), [0048]; APPLE-1005, [0028], [0049], [0062]; APPLE-1101, 20-28, 54-60. Murakoshi's transmitter 212 is a component of the apparatus and performs the same function as the claimed "output module" (as I will further explain below with regard to element [1d-v]).



APPLE-1004, Fig. 2 (annotated)

[1c-v] said routing module receiving said data signals from said sensor,

154. Murakoshi-Stewart renders this element obvious, at least because Murakoshi discloses a receiver (routing module) that routes and receives data signals from the sensor. *See supra* §IX.A.4.[1c-ii]. Murakoshi describes that "the receiver 210 may receive the vibratory signal generated by the sensor 206." APPLE-1004, [0032].. In particular, Murakoshi describes that the apparatus includes a receiver that "may comprise suitable logic, circuitry, interfaces, and/or

code that may be operable to receive data and messages." APPLE-1004, [0032], [0018], [0025].

155. A POSITA would have understood from Murakoshi's disclosure that the server includes a receiver for receiving the vibratory signals from the accelerometer. *See* APPLE-1004, [0032]. The function of Murakoshi's receiver to "receive the vibratory signal" from the sensor is the same as the claimed function of the receiving module. Additionally, a POSITA would have understood that, in Murakoshi-Stewart, the receiver receives signals from the accelerometer that must be routed within the server to the processor for processing to take place. APPLE-1004, [0026], [0036], [0089], Fig. 2.

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and

156. Murakoshi-Stewart renders this limitation obvious, at least because Murakoshi teaches a processor ("processing module") that determines a data pattern ("vibratory signal components") corresponding to the data signals and matches the data pattern with a gesture profile ("control signal corresponding the one or more generated vibratory signals"). APPLE-1004, [0038]; *see also* §IX.A.4.[1c-iii]. Murakoshi describes that, after detection of the vibrations (data signals), the apparatus may "generate one or more vibratory signals in response to the detected one or more vibrations" and the processor (processing module) is then

able to "generate a control signal corresponding to the one or more generated vibratory signals to control the user interface of the device." APPLE-1004, [0013]. The processing module "convert[s] each of the generated one or more vibratory signals into vibratory signal components," and a POSITA would have understood that vibratory signal components, per Murakoshi, make up a data pattern determined by the processor and corresponding to the data signals of the object interacting with the vibratory surface (mounting surface), per Murakoshi. APPLE-1004, [0038]. Murakoshi describes that the processor operates "to convert each of the generated one or more vibratory signals into vibratory signal components." *Id.* This is similar to the description in the '738 patent that the data signal includes various features such as peaks and relative timings which are identified as a "data pattern." APPLE-1001, 5:5-8 ("A data pattern for each contact interaction is determined by each defined peak and the defined time period after the defined peak, and each measured time period between each defined peak, if there is a plurality of impacts"). For example, Murakoshi describes determining a vibration frequency associated with an interaction of an object with the vibratory surface from the vibratory signals. APPLE-1004, [0015], [0028], [0042]-[0044]. Accordingly, in the same way that the '738 patent processing module "determin[es] a data pattern corresponding to said data signals of said contact interaction" by identifying features of the data signals, Murakoshi teaches that a

processor identifies vibratory signal components such as a frequency from the vibratory data.

157. Additionally, in Murakoshi-Stewart, the processor uses the vibratory signal components (data patterns), such as the vibration frequency, to identify a corresponding control signal, per Murakoshi. APPLE-1004, [0015] ("The determined vibration frequency is indicative of an operation associated with the device"). In particular, Murakoshi describes that "the processor 202 may determine a control signal that corresponds to the determined vibration frequency based on frequency-operation mapping data stored in the memory 204." APPLE-1004, [0048], [0023], [0025], [0027], [0036], [0048].

158. Murakoshi describes that a user or manufacturer "may define an operation of the device 102 to be controlled that corresponds to a vibratory signal produced in response to an interaction of the object 108 with the vibratory surface 106." APPLE-1004, [0049]. As an example, "the manufacturer and/or the user may define the vibration frequency that corresponds to scratching on the vibratory surface 106 that may indicate volume control operation of a television." *Id.* As another example, "the manufacturer and/or the user may define the vibratory frequency that corresponds to tapping within a pre-defined region on the vibratory surface 106 that may indicate channel change operation of the television." *Id.* "Thus, by tapping within the pre-defined region on the vibratory surface 106, the

user may change channels of the television. Accordingly, Murakoshi describes that the data pattern (e.g., a determined frequency of the vibratory signal) of the vibratory signal is mapped or matched to a gesture profile (e.g., a frequency of a frequency-operation mapping) that is associated with a command (e.g., an operation of a frequency-operation mapping). APPLE-1004, [0048].

159. Based on Murakoshi's disclosure, a POSITA would have understood from Murakoshi's disclosure that the processor of Murakoshi-Stewart determines vibratory signal components including vibration frequency (data pattern) and matches the data pattern to frequency-operation mapping data to identify the corresponding control signal—a gesture profile associated with a command.

[1d-i] a terminal device

160. Under Haptic's apparent understanding of a "terminal device," Murakoshi-Stewart renders obvious a "terminal device" at least because Murakoshi teaches a device (such as a laptop, computer, television, lamp or other home appliance) that performs an action associated with a received control signal. APPLE-1004, [0017] ("[t]he device 102 may correspond to a machine that may be operated by a user" such as lamps or "mobile phones, ***laptops, tablet computers***, ***televisions***, Personal Digital Assistant (PDA) devices, vehicles, ***home appliances***, media playing devices, and/or any other device operable by a user"); §VIII (Claim Construction).

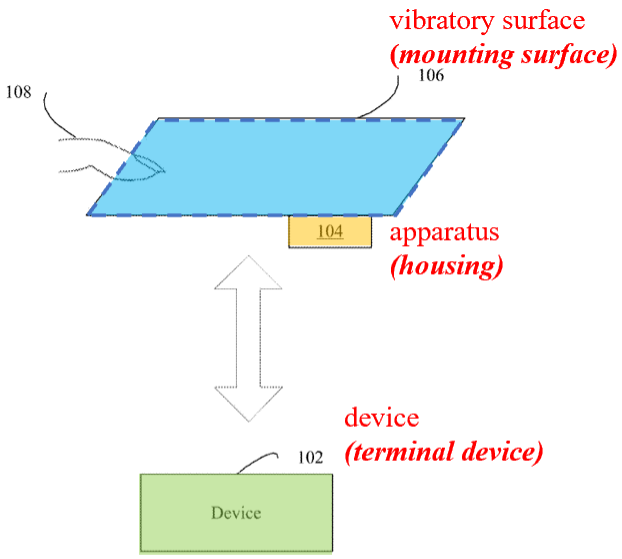


FIG. 1

APPLE-1004, Fig. 1 (annotated)

161. Murakoshi also describes use of the apparatus with a lamp. APPLE-1004, [0064] ("The apparatus 104 may generate a control signal in response to scratching on the table to switch on and/or switch off the lamp"), [0084] ("A lamp 704 and/or a fan may be examples of a device with which the apparatus 104 may interact.").

[1d-ii] being comprised of a receiving module

162. Under Haptic's apparent understanding of this claim term, Murakoshi-Stewart renders obvious a "receiving module" of the terminal device because Murakoshi discloses that the device 102 (i.e., terminal device) includes "***one or more processors and/or circuits… operable to receive a control signal from***

the apparatus 104." APPLE-1004, [0093] (emphasis added); §VIII (Claim Construction). As will be further described below with regard to element [1d-v], Murakoshi's processors and/or circuits are operable to perform the same function as the claimed "receiving module," and accordingly, a POSITA would have understood Murakoshi's processors and circuits of the device 102 to be equivalent to the claimed "receiving module" of the terminal device.

[1d-iii] and means for initiating activity of said terminal device corresponding to said command,

163. Under Haptic's apparent understanding of this claim term, the "means for initiating activity" is a §112(f) term that has the function of initiating activity of the terminal device corresponding to the command (this is the function as described in the claim language, but see also APPLE-1001, 5:43-55), and has a corresponding structure broad enough to include switches, transistors, physical actuators, other actuating mechanisms, and equivalents thereof for changing the status of a terminal device. §VIII (Claim Construction); APPLE-1101, 31-33, 64-66. Murakoshi-Stewart renders obvious "means for initiating activity" (e.g., a switch or actuating mechanism) of a terminal device (e.g., device 102) that initiates activity of said terminal device corresponding to said command.

164. For example, Murakoshi discloses that "[t]he apparatus 104 may generate a control signal ***to switch on*** a lamp placed on the table when a user may scratch on the center of the table." APPLE-1004, [0023] (emphasis added).

Murakoshi also describes that "[t]he control signal may switch on and/or switch off the home appliance." APPLE-1004, [0050].

165. Murakoshi describes that the (terminal) device 102 can include processors and circuits, and these "processors and/or circuits may be operable to control a user interface of the device 102 based on the received control signal." *Id.*, [0093]. Accordingly, Murakoshi discloses that the terminal device includes processors and/pr circuits that can change a status (e.g., on or off) of the terminal device (e.g., a lamp or home appliance) based on the control signal. Based on Murakoshi's disclosure of the change in status of the terminal device in response to the control signal (e.g., control signal ***to switch on*** a lamp), a POSITA would have understood the device (terminal device) of Murakoshi-Stewart necessarily includes a switch or other actuating mechanism (means for initiating activity) that initiates the activity associated with the control signal received by the device. APPLE-1004, [0023], [0050]. It would have been obvious to a POSITA that a switch or another mechanism would be required to implement the status change (e.g., on/off) that Murakoshi describes. A POSITA would have further understood that a terminal device that executes a status change in response to a control signal would include actuators that operate the terminal device and switches the device between statuses – for example, a processor and/or circuits as Murakoshi describes. APPLE-1004, [0093], [0063], [0065]-[0066].

[1d-iv] said terminal device being in communication with said server,

166. Murakoshi discloses that that "[t]he processor 202 may communicate the generated control signal to the device 102 via the transmitter 212." APPLE-1004, [0048]. Further, Murakoshi describes that "[t]he device 102 is communicatively coupled to an apparatus 104 (FIG. 1) [such that the] one or more processors and/or circuits may be operable to receive a control signal from the apparatus 104." *Id*., [0093]. As described above, under Haptic's apparent understanding of this claim term, the processor, per Murakoshi, is a component of the server. §VIII (Claim Construction); §IX.A.4.[1c-i].

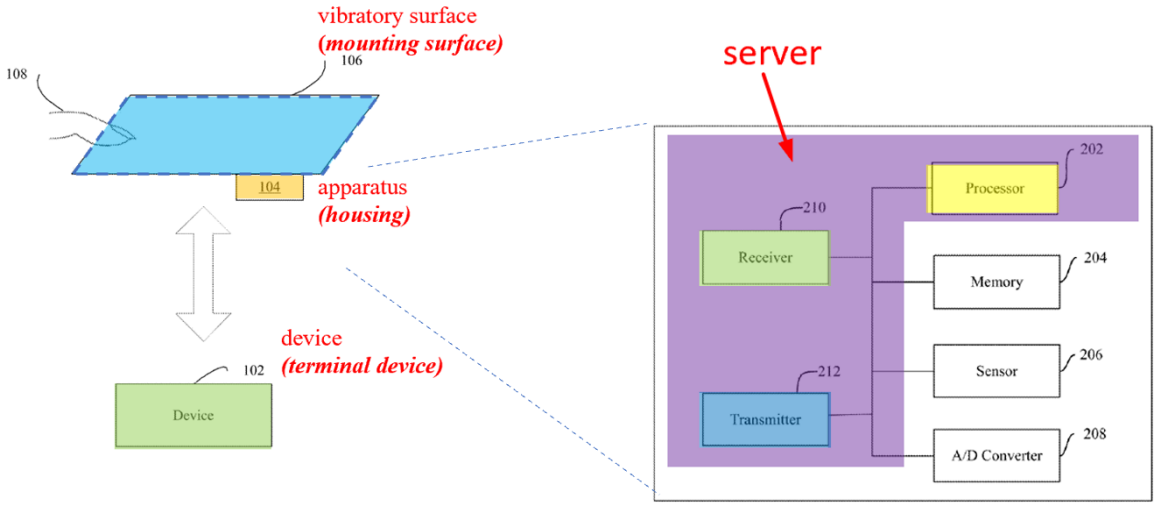


FIG. 1

APPLE-1004, Fig. 1 (annotated and modified to include Fig. 2)

167. Murakoshi discloses a method for "controlling a user interface of a device based on vibratory input" in a system including "a device 102, an apparatus

104 for controlling a user interface of the device 102." APPLE-1004, [0016], [0018], [0023] ("[t]he control signal may switch on and/or switch off the home appliance"), Fig. 1. Murakoshi describes that "[t]he processor 202 may communicate the generated control signal to the device 102 via the transmitter 212." APPLE-1004, [0048], [0033]. Accordingly, a POSITA would have understood that the terminal device of Murakoshi-Stewart is communicatively coupled to the server via the transmitter.

[1d-v] said output module transmitting said command to said receiving module,

168. Under Haptic's apparent understanding of this claim limitation, Murakoshi-Stewart renders this limitation obvious, at least because Murakoshi discloses a transmitter ("output module") that outputs and transmits a command to processors and/or circuits ("receiving module") of a terminal device. §VII (Claim Construction); §IX.A.4.[1c-iv]; APPLE-1004, [0048] ("[t]he processor 202 may communicate the generated control signal to the device 102 via the transmitter 212"). Murakoshi describes that "transmitter 212 may transmit a control signal to control the user interface of the device 102" (APPLE-1004, [0033]), and further that "one or more processors and/or circuits [of device 102] may be operable to receive a control signal from the apparatus 104." APPLE-1004, [0093]. Accordingly, Murakoshi discloses that the transmitter (routing module) transmits a

control signal (command) to the processors/circuits (receiving module) of the device 102 (terminal device).

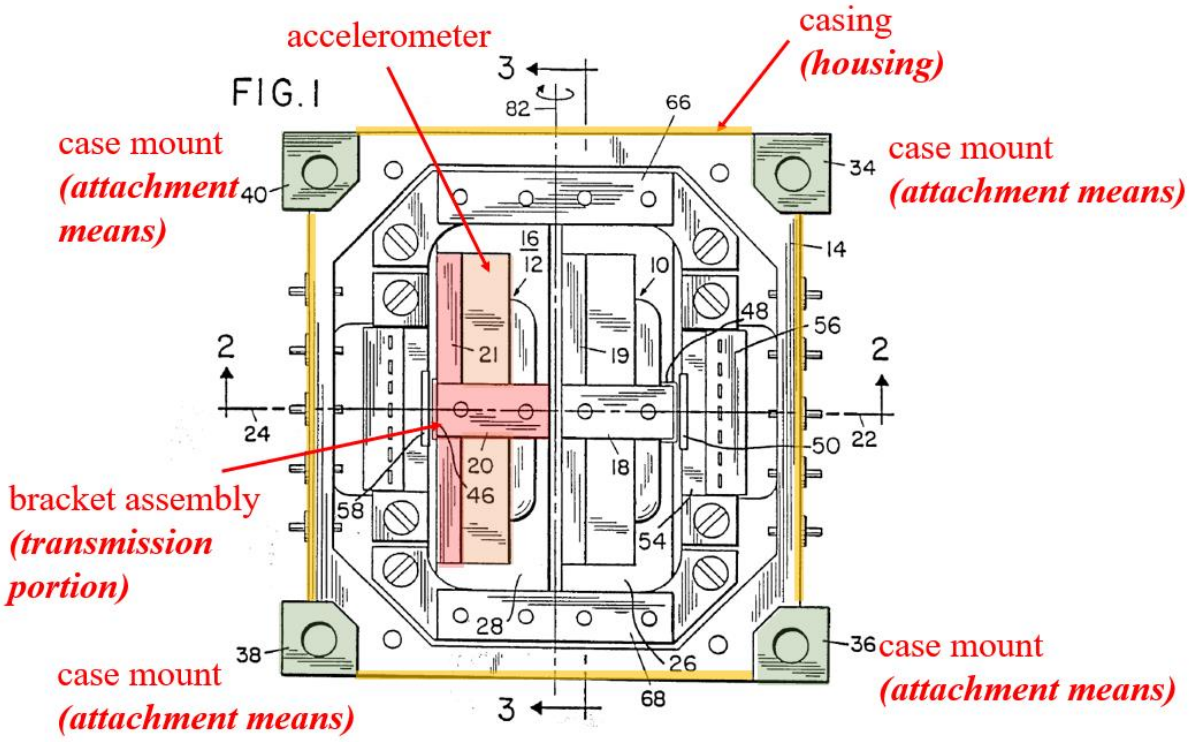
169. For example, Murakoshi describes that "[t]he apparatus 104 may generate a control signal to switch on a lamp placed on the table when a user may scratch on the center of the table" where the lamp is a terminal device. APPLE-1004, [0023]. Additionally, Murakoshi describes that "[t]he control signal may switch on and/or switch off the home appliance" where the home appliance is a terminal device. *Id*., [0050]. Accordingly, Murakoshi describes that the transmitter 212 transmits the control signal to the terminal devices, such as lamps and home appliances, and the control signal is received at processors/circuits (receiving module) of the terminal device as described above. *Id.*, [0033], [0048], [0093].

[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion.

170. Under Haptic's construction, based on the Joint Claim Construction statement, "engagement means" is treated under §112(f) as a means-plus-function term which functions to attach said housing to said mounting surface, connect said sensor to attachment means of said housing, set a rigid position of said sensor

relative to the mounting surface, and transmit data signals from the attachment means to said sensor. §VIII (Claim Construction). Under Haptic's apparent understanding of the limitation as evidenced by the infringement contentions, the corresponding structure is broad enough to include threaded screws and screw holes in a logic board assembly (attachment means), and a portion of a logic board that connects a sensor to the "attachment means" (transmission portion). APPLE-1101, 9-12, 33-35, 43-45, 67-68; §VIII (Claim Construction). Murakoshi-Stewart renders this element obvious because Stewart teaches relevant structures for performing the same functions.

171. In particular, Murakoshi-Stewart renders obvious the claimed "attachment means" at least because Murakoshi-Stewart is implemented such that the casing includes case mounts, per Stewart, that a POSITA would have understood are used with mechanical fasteners to attach the housing to the mounting surface. APPLE-1006, 5:8-9 ("accelerometers are positioned within a cavity 16 within the case 14."), 5:34-37 (referring to "case mounts"), Fig. 1; APPLE-1004, [0021]; §IX.A.3 (Murakoshi-Stewart Combination); *see* APPLE-1039, 1; APPLE-1049, [0028], APPLE-1048, [0082], [0059]. As described above (*supra* §V.B.4), an accelerometer must be firmly attached to the surface on which it is intended to sense vibrations in order to accurately sense accelerations of the surface without unnecessary attenuation of the vibrational motion.



APPLE-1006, Fig. 1 (annotated)

172. Additionally, Murakoshi-Stewart renders obvious a "transmission portion" at least because it is implemented with a bracket assembly that connects the sensor to the case mounts and fasteners (attachment means) of the casing (housing), per Stewart. APPLE-1006, 5:8-33, 5:54-61; APPLE-1004, [0013], [0020], [0023], [0029]-[0030], [0036]; §VIII (Claim Construction); *see* APPLE-1039, 1; APPLE-1049, [0028], APPLE-1048, [0082], [0059]. Just as the accelerometer must be firmly attached to the surface on which it senses, the accelerometer also would be secured within the housing to allow vibrations of the surface to be passed to the accelerometer for accurate sensing. *Supra* §VI.B.3.

173. Murakoshi-Stewart's brackets and case mounts with fasteners collectively perform the same function as the claimed "engagement means." That is, the brackets fasten the accelerometer within the housing (i.e., relative to the attachment means) and the case mounts and fasteners couple the housing to the vibrational surface. Additionally, in the Murakoshi-Stewart combination, the brackets and case mounts with fasteners also perform the additional functions of the claimed engagement means including "rigid[ly] position[ing]… said sensor relative to said mounting surface, [and] generating said data signals of said sensor through said transmission portion," as will be further described below.

Connecting the sensor to the attachment means of the housing to set a rigid position of the sensor relative to the mounting surface

174. Stewart describes that "[a]ccelerometer 10 is attached to ***a three-part bracket assembly*** that includes the finger 18 and the beam 19." APPLE-1006, 5:9-11. Further, Stewart describes that the accelerometer is attached within the casing (housing) by the bracket assembly and by spaced fingers and sidebeams that extend the length of the cavity, which allows the accelerometer to vibrate within the casing. APPLE-1006, 5:54-61. Stewart discloses the accelerometer (sensor) is held by the bracket assembly within the casing (housing) so that the accelerometer is protected and held in a position such that it can sense vibrations efficiently and without interference. APPLE-1006, 5:8-20, 5:54-61. Stewart's teaching to use

components like brackets to hold an accelerometer within a housing, along with the teaching to firmly attach the housing to a surface with case mounts, collectively function to couple a sensor to the housing and the housing to a mounting surface. That is, the sensor is held in a particular position within the housing and relative to the surface that the housing is mounted to.

Transmission portion …being comprised of a material with flexibility different than said mounting surface

175. A POSITA would have understood that Murakoshi-Stewart secures the accelerometer in position using brackets that have particular material qualities to allow the transmission of vibrations to the accelerometer. A POSITA would have further understood that the material—and the material characteristics—of the brackets (transmission portion) would be different from the material and material characteristics of the vibrational surface (mounting surface). For example, Murakoshi describes that a vibratory surface can be a table top and discloses that the vibratory surface can be composed of a variety of materials including "wood, glass, plastic, metal, cardboard, concrete, and the like." APPLE-1004, [0020]-[0021], [0023], [0064], [0076]-[0077]. A POSITA would have understood that the composition and structure of the bracket assembly would be a different material than the vibratory surface (e.g., a tabletop), per Murakoshi, because of differences in material and/or thickness of the feature. *Id.*, [0020] ("The vibratory

surface 106 may correspond to any surface capable of generating vibrations… Examples of such vibratory surface 106 may include, but are not limited to, a table top, a wall, a cover of the device, and/or any surface capable of generating vibrations"), [0030], [0023]. Significantly, a POSITA would have recognized that the difference in materials, and, in particular, a difference in the flexibility of the components, would allow for advantageous transmission of vibrations from the mounting surface to the transmission portion and from the transmission portion to the sensor.

176. Further, as described above, a POSITA would have understood that the brackets and casing described by Stewart hold the sensor rigidly in place relative to the attachment means, and thus also hold the sensor in a rigid position relative to the vibratory surface. *Supra* §IX.A.4.[1b-v] (claim limitation reciting "said sensor being in a fixed position relative to said engagement means"); APPLE-1006, 5:8-33, 5:54-56. A POSITA would have understood that the sensor must be held in a fixed position relative to the measured surface, in order to have a fixed reference point for detection of vibratory signals and processing of those signals in a meaningful way.

Transmitting data signals generated by the contact interaction through said transmission portion to the sensor

177. Finally, regardless of the exact bounds of "said contact interaction generating said data signals of said sensor through said transmission portion," Murakoshi-Stewart includes at least the '738 patent's preferred embodiment. The '738 patent states that "[t]he contact interaction 60 is detected as data signals 70 by the sensor 30…." APPLE-1001, 10:57-59, Fig. 2. Like the '738 patent, Murakoshi-Stewart's contact interaction (e.g., a tap/scratch on the vibratory surface) is detected as data signals (vibratory signals) by the sensor (accelerometer). APPLE-1004, [0020], [0023], [0029]-[0030], [0036]; APPLE-1006, 5:8-20, 5:54-6:1; *see supra* Element [1a] and [1b-vi].

178. Murakoshi discloses that "in response to the interaction of the object 108 with the vibratory surface 106, the ***sensor 206 may sense vibrations generated in the vibratory surface 106***." APPLE-1004, [0036], [0013] (emphasis added). Per Murakoshi, Murakoshi-Stewart's "sensor 206 may be operable to generate one or more ***vibratory signals in response to the detected one or more vibrations***." *Id.*, [0029], [0036] (emphasis added). Accordingly, and as I described above, the vibrations from the contact interaction with the mounting surface are detected by the sensor as data signals.

179. Additionally, a POSITA would have understood that the vibrations are transmitted from the mounting surface through the attachment means to the housing, through the housing to the transmission portion, and from the transmission portion to the accelerometer to be sensed. In the Murakoshi-Stewart combination, the vibrations are transmitted from the vibratory surface to the housing through the case mounts and fasteners (engagement means), and then from the housing to the brackets (transmission portion) and finally to the accelerometer. A POSITA would have understood that this transmission of vibrations is common to accelerometers. *See e.g.*, APPLE-1046 ("Accelerometers 20 are disposed in area 4 with a physical connection to one or more solid surfaces 6 to allow vibrations to transmit from the surfaces 6 tapped by users 2 to the surfaces 6 in physical contact with accelerometers 20 [such that] vibrations transmit though any solid materials of area 4 between the tapped surfaces 6 and the surfaces in physical contact with accelerometers 20").

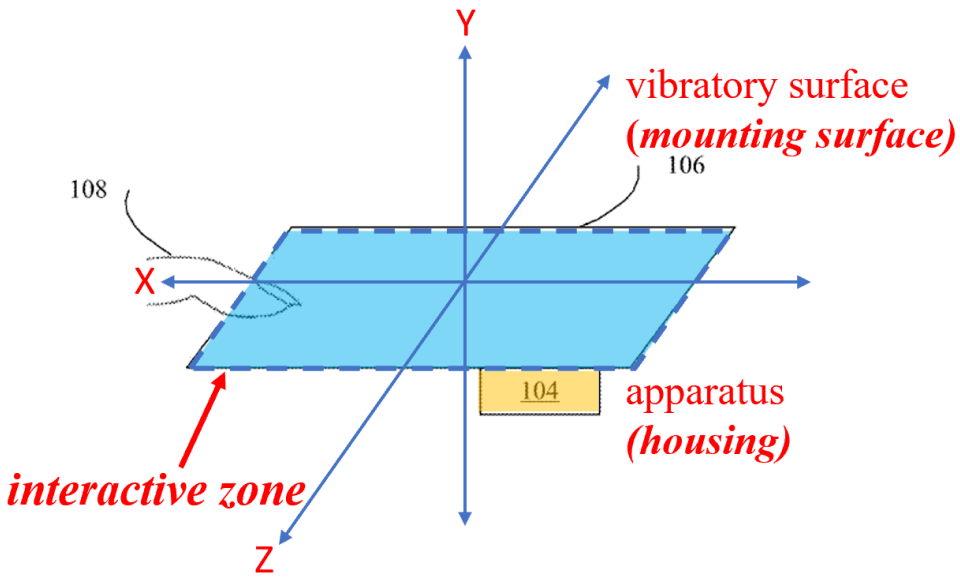
180. Similarly, Stewart describes that in an example, an accelerometer includes an inertial mass member "positioned and suspended to react to and to provide a signal that is a measure of acceleration of the supporting structure along a predetermined axis." APPLE-1006, 6:20-32. A POSITA would have understood that the vibrations of the surface to which the accelerometer housing is affixed are passed to the accelerometer through the structures that couple the accelerometer to

the surface, including the brackets (i.e., transmission portion). Accordingly, from Murakoshi's and Stewart's disclosure, a POSITA would have understood that the vibrations (data signals) associated with a user's tapping on the vibratory surface (contact interaction) is transmitted to the accelerometer (sensor) through the bracket assembly (transmission portion).

d) Claim 2

[2] The control system, according to claim 1, wherein said interactive zone of said sensor aligns with said mounting surface, said interactive zone being coplanar with said mounting surface.

181. As described above in Element [1b-iv] (which recites "said interactive zone being aligned with said mounting surface"), under Haptic's apparent understanding of this claim term, Murakoshi discloses that the pre-defined region of the vibratory surface (interactive zone) aligns with the surface of the table top (mounting surface) because the pre-defined region of the surface is a part of the surface of the table top. APPLE-1004, [0021]; §IX.A.4.[1b-iv]; APPLE-1101, 38, 71. Briefly, and as described above, a POSITA would have understood that a region formed on or in a surface (as Murakoshi's pre-defined region is formed on the vibratory surface) is ***aligned with*** the surface because the interactive zone and mounting surface are formed as X-Z planes, as shown in Fig. 1 of Murakoshi below.



APPLE-1004, Fig. 1 (annotated and modified to include axis)

182. The second element of claim 2 recites "said interactive zone being coplanar with said mounting surface." Murakoshi's pre-determined region (interactive zone) is coplanar with the vibratory surface (mounting surface). As illustrated above in Fig. 1, because Murakoshi explains that the pre-defined region of the vibratory surface (interactive zone) is defined on the vibratory surface, the predefined region (interactive zone) is ***coplanar*** with the vibratory surface (mounting surface) that it is formed on – they both lie in the ***same*** X-Z plane. APPLE-1004, [0021] ("a pre-defined region of a surface may correspond to the vibratory surface 106"), [0020] ("The vibratory surface 106 may correspond to any surface capable of generating vibrations"), [0029].

e) Claim 8

[8] The control system, according to claim 1, wherein said terminal device is comprised of one device selected from a group consisting of: a television, a thermostat, a computer, a software system, a game console, a fan, a mattress adjustor, an alarm clock, and a lighting fixture.

183. Murakoshi discloses that the device 102 (terminal device) can be a television, computer, home appliance, media playing device, fan, or lamp. For example, Murakoshi describes that "[t]he device 102 may correspond to a machine that may be operated by a user" such as "mobile phones, ***laptops, tablet computers***, ***televisions***, Personal Digital Assistant (PDA) devices, vehicles, ***home appliances***, media playing devices, and/or any other device operable by a user." APPLE-1004, [0017]. Murakoshi also describes that "[a] user operating the ***lamp*** may scratch on the table [and the] apparatus 104 may generate a control signal in response to scratching on the table to switch on and/or off the lamp." APPLE-1004, [0064], [0084] ("A lamp 704 and/or ***a fan*** may be examples of a device with which the apparatus 104 may interact.").

184. A POSITA would have understood that the devices 102 (i.e., terminal devices) discussed in Murakoshi are the same as many of the devices making up the group of devices in claim 8. For example, a POSITA would have noted that Murakoshi explicitly describes that the device 102 controlled by the apparatus can be a television, a computer, a fan, and a lamp (i.e., a lighting fixture). APPLE-1004, [0017], [0084]. A POSITA would have also recognized that Murakoshi's

description of device 102 including "an electrical device, a mechanical device, an electronic device, and/or a combination thereof" is expansive. A POSITA would have understood that Murakoshi discloses many of the devices in the claimed list of devices, and that Murakoshi's apparatus and system would be operable with any of the devices in the list based on Murakoshi's disclosure.

f) Claim 9

[9] The control system, according to claim 1, further comprising: an additional terminal device being comprised of an additional receiving module and additional means for initiating activity of said additional terminal device corresponding to an additional command, said additional terminal device being in communication with said server, said output module transmitting said additional command to said additional receiving module.

185. Murakoshi discloses that the apparatus is operable with multiple devices (terminal devices). Murakoshi describes that "the apparatus 104 may be operable to interact with a plurality of devices using the vibratory surface 106." APPLE-1004, [0051]. Additionally, Murakoshi describes that "a single apparatus may interact with one or more devices in a room." *Id.*, [0085].

186. Murakoshi describes that in an example, "the processor 202 may interact with a mobile device based on the generation of a control signal that corresponds to scratching on the vibratory surface 106 [and] the processor 202 may interact with a home applicant in response to a tap on the vibratory surface 106." *Id.*, [0051]. Murakoshi's "processor 202 may be operable to register one or more devices (such as the device 102)" and when a control signal has been generated,

"the processor 202 may communicate the generated control signal to the registered device." *Id*., [0053]. First, from Murakoshi's disclosure, a POSITA would have understood that each of the terminal devices is in communication with the server (i.e., in communication with the processor, a component of the server under Haptic's interpretation, via the transmitter, another server component). Second, a POSITA would have understood from Murakoshi's disclosure that each of the terminal devices with which the apparatus can communicate includes processors and circuitry for receiving a control signal (i.e., an additional receiving module, *see* Element [1d-ii]) and a switch or other circuitry for implementing the status change associated with the control signal (i.e., means for initiating activity, *see* Element [1d-iii]). *Id.*, [0023], [0033], [0048], [0050], [0093]. Third, a POSITA would have appreciated that the transmitter, which operates to transmit the control signal from the processor to the terminal device, per Murakoshi, is in communication with each of the terminal devices controlled by the apparatus and transmits the control signal to the receiving module of each. *See supra* §IX.A.4.[1d-v].

187. Accordingly, Murakoshi discloses an additional terminal device that would have the same ability to receive control signals at a receiving module as the terminal device described in claim 1. APPLE-1004, [0093], [0023], [0033].

g) Claim 10

188. Claim 10 is written as a method claim. Nonetheless, the limitations of claim 10 correspond substantially to the limitations of claim 1, and the reasons that each step of the claimed method is rendered obvious by Murakoshi-Stewart are explained above with regard to claim 1. In the below table, I show the correspondence of each of the limitations of claim 10 to the limitations of claim 1 addressed above:

	Claim 10 language	Corresponding claim 1 limitation
[10pre]	A method of controlling a terminal device, the method comprising the steps of:	[1pre] A control system comprising:
[10a]	installing a housing on a mounting surface by an engagement device,	[1a] a housing having an engagement means for a mounting surface;
[10b-i]	said housing being comprised of a sensor contained within said housing,	[1b-i] a sensor contained within said housing,
[10b-ii]	said sensor being comprised of an accelerometer,	[1b-iii] said sensor being comprised of an accelerometer,
[10b-iii]	said sensor forming an interactive zone defined by a range of said sensor, said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing,	[1b-ii] said sensor forming an interactive zone defined by a range of said sensor, [1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing,

[10b-iv]	said sensor being in a fixed position relative to said engagement device,	[1b-v] said sensor being in a fixed position relative to said engagement means,
[10c]	wherein said engagement device of said housing comprises: an attachment device between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment device of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface;	[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion.
[10d-i]	connecting a server in communication with said sensor,	[1c-i] a server in communication with said sensor,
[10d-ii]	said server being comprised of a routing module,	[1c-ii] said server being comprised of a routing module,
[10d-iii]	a processing module being connected to said routing module,	[1c-iii] a processing module being connected to said routing module, and
[10d-iv]	and an output module connected to said processing module;	[1c-iv] an output module connected to said processing module,
[10e-i]	connecting a terminal device in communication with said server,	[1d-i] a terminal device [1d-iv] said terminal device being in communication with said server,

[10e-ii]	said terminal device being comprised of a receiving module;	[1d-ii] being comprised of a receiving module
[10f]	making a physical impact on said mounting surface so as to generate a contact interaction;	[1b-v] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals, said contact interaction being comprised of an impact on said mounting surface, said data signals being comprised of vibration data of said contact interaction;

[10g]	detecting said contact interaction as data signals with said sensor, said data signals being comprised of vibration data of said contact interaction, said contact interaction generating said data signals of said sensor through said transmission portion;	[1b-v] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals, said contact interaction being comprised of an impact on said mounting surface, said data signals being comprised of vibration data of said contact interaction; [1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion
[10h]	receiving said data signals from said sensor with said routing module of said server;	[1c-v] said routing module receiving said data signals from said sensor,

[10i]	determining a data pattern corresponding to said data signals of said contact interaction with said processing module;	[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and
[10j]	matching said data pattern to a gesture profile with said processing module, said gesture profile being associated with a command;	[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and
[10k-i]	transmitting said command to said receiving module of terminal device with said output module of said server,	[1d-v] said output module transmitting said command to said receiving module,
[10k-ii]	said command corresponding to activity of said terminal device; and	
[10l]	performing said activity with said terminal device.	

[10pre]-[10k-i]

189. Murakoshi-Stewart renders obvious elements [10p]-[10k-i] for the same reasons as described above with regard to claim 1. *Supra* §§IX.A.4.[1pre]-[1e].

190. As shown in the table above, although there are minor differences in the claim language used in claim 10 compared to claim 1 (for example, claim 10 recites an "engagement device" instead of an "engagement means" and recites an "attachment device" instead of "attachment means"), the mappings of the claim 10 elements to the prior art references described above with regard to claim 1 remains the same.[7] It would have been obvious to a POSITA that the steps of claim 10 that involve "connecting" various components of the system are met by the disclosures of Murakoshi described above because Murakoshi describes the components as connected to or in communication with one another. Elements [10pre]-[10k-i] of claim 10 do not add any meaningful limitations to claim 1, and are fully met by the combination of references described above.

191. Additionally, limitations [10k-ii] and [10l] are rendered obvious by Murakoshi-Stewart for the reasons provided below.

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[7] Regardless of whether § 112(f) is determined to apply to "engagement device" or "attachment device," the analyses of "engagement means" and "attachment means" with respect to claim 1 also apply and explain how the prior art teaches and/or renders obvious "engagement device" and "attachment device," respectively.

[10k-ii] said command corresponding to activity of said terminal device; and

192. Murakoshi discloses that the control signal (command) indicates an operation of device 102 (terminal device) to be controlled (corresponds to activity of said terminal device). For example, Murakoshi describes "[t]he control signal indicates an operation of the device 102 to be controlled in response to the interaction." APPLE-1004, [0048], [0023] ("[t]he apparatus 104 may generate a control signal ***to switch on*** a lamp placed on the table when a user may scratch on the center of the table"), [0050] ("The control signal may ***switch on and/or switch off*** the home appliance").

193. Accordingly, Murakoshi describes that the control signals are commands that correspond to a particular action or activity of the device – a control signal (command) can correspond to powering on or off the device, for example. APPLE-1004, [0023] ("[t]he apparatus 104 may generate a control signal ***to switch on*** a lamp placed on the table when a user may scratch on the center of the table"), [0050] ("The control signal may ***switch on and/or switch off*** the home appliance").

[10l] performing said activity with said terminal device.

194. Murakoshi discloses that "[t]he device 102 may process the received control signal and perform the operation indicated by the control signal." APPLE-1004, [0084], [0048].

195. Accordingly, Murakoshi teaches that the control signal (command) corresponding to an action (*supra* §IX.A.4 Element [10k]) is received by the device and that the device then performs that action. For example, Murakoshi describes that a control signal to power down a mobile phone can be transmitted, and "[b]ased on the received control signal, the mobile phone 502 may be switched off"). APPLE-1004, [0077].

B. GROUND 1B: THE MURAKOSHI-STEWART-SACHS COMBINATION RENDERS CLAIMS 1-2, 4-5, AND 8-11 OBVIOUS

196. Discussion below covers Ground 1B under Haptic's constructions and apparent understandings of the claim terms as evidenced by the Joint Claim Construction statement and infringement contentions. *See generally* APPLE-1101; APPLE-1107. In the below discussion, I refer to Haptic's infringement contentions (APPLE-1101), as well as to the claim construction section above when necessary to explain Haptic's understandings of certain claim terms. §VIII (Claim Construction).

1. Sachs

197. Sachs describes "[m]obile devices using motion gesture recognition" where "[m]otion gesture(s) are recognized from the motion data from a set of motion gestures available for recognition in the active operating mode." APPLE-1007, Abstract. Sachs describes that "[a] tap gesture typically includes the user

hitting or tapping of the device 10 with a finger, hand, or object sufficiently to cause a large pulse of movement of the device in space." *Id*., [0101]. In some instances, "three tap gestures may be required to be detected instead of just one." *Id.*, [0112].

198. Sachs describes methods for detecting various types of user gestures by a mobile device and processing sensor data associated with the user gesture to identify the gesture. Sachs describes that by identifying "data features" in the captured sensor data, a user's intended gesture can be identified more efficiently than using the full sensor data set to identify a feature. APPLE-1007, [0015], [0079], [0120]. "Data features… are characteristics of the waveform 350 of motion sensor data that can be detected from the waveform 350 and which can be used to recognized that a particular gesture has been performed." APPLE-1007, [0123]. Sachs' data features include "a maximum (or minimum) height (or magnitude) 354 of the waveform 350" and "time values appropriate to the data feature detected." APPLE-1007, [0123], [0126].

199. Sachs describes that "[a] tap gesture typically includes the user hitting or tapping of the device 10 with a finger, hand, or object sufficiently to cause a large pulse of movement of the device in space [and a] tap gesture can be used to control any of a variety of functions of the device." *Id.*, [0101]. Sachs depicts example "motion data for a tap gesture" in Figs. 11A-B and 12A-B (reproduced

below).[8] *Id*., [0102]. "[D]etecting a tap gesture is performed by examining motion sensor data to detect a gesture relative to a background noise floor." *Id.* "FIG. 11A shows a waveform 280 resulting from a tap gesture when a device 10 is held loosely in a user's hand." *Id.* "FIG. 11B shows a waveform 288 resulting from a tap gesture when a device 10 has been placed on a desk or other hard surface and then tapped." *Id.*

[8] Note that the discussion of Figs. 11A-B in Sachs refers to some of the features depicted in Figs. 12A-B.

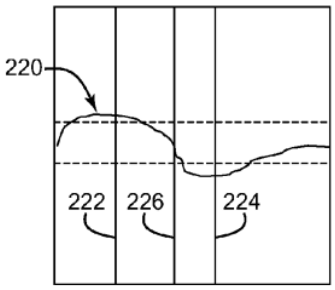


FIG. 11A

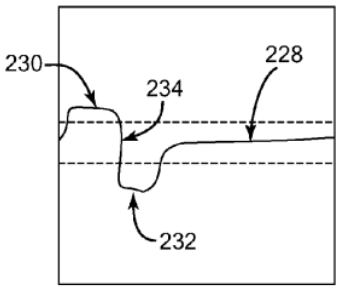


FIG. 11B

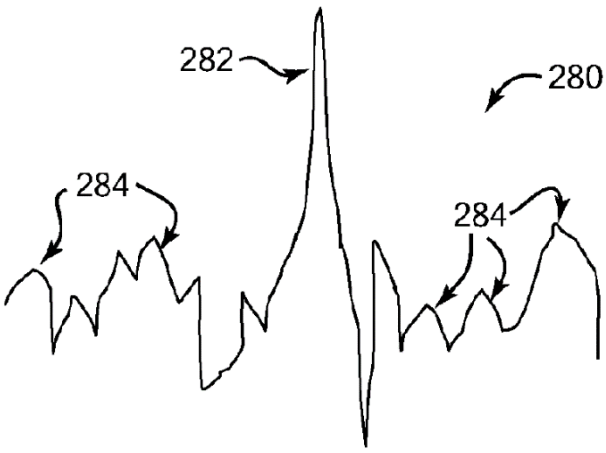


FIG. 12A

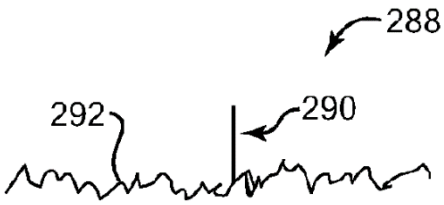


FIG. 12B

Top: APPLE-1007, Figs. 11A-B

Bottom: APPLE-1007, Figs. 12A-B

200. Sachs describes that "[t]o provide a more flexible recognition of gestures that takes into account variance in gesture feature timing, an aspect of the present invention recognizes gestures using relative timing requirements." *Id.*, [0079]. "Some gestures may require particular features (i.e., characteristics) of the sensor data to occur in a particular sequence and with a particular timing." *Id.*,

[0078]. Sachs describes that "the timing between different features in motion data can be expressed and detected based on multiples and/or fractions of a basic time period used in that gesture [and t]he basic time period can be, for example, the time between two data features." *Id*., [0079]. For example, when a gesture requires three features (features 1-3) to occur in a particular sequence, different users may perform the gesture with slightly different timings between features. *Id*., [0078]. "If the timing values are hard-coded, then many different ranges of values will need to be stored, and it will be difficult to cover all possible user variances and scenarios." *Id.* Sachs describes that "when relative timing is used, for whatever time t1 exists between features 1 and 2 of a gesture, the time between features 2 and 3 can be defined as approximately two times t1 [to] allow[] different users to perform gestures at different rates without requiring [computationally expensive] algorithms." *Id.* In application, Sachs describes that during processing of the gesture, the system "can time each feature" and "[i]f the features occur within a certain predetermined time of each other, the gesture will be considered recognized and will trigger" the associated action. *Id.*, [0096]; *see also id.*, [0126]-[0127].

201. Sachs also describes mechanisms for determining completion of a gesture, including recognition of a valid gesture from motion data (*id.*, [0119]) and detection of a period in which no further motion data is detected (*id*., [0094]). *Id.*, [0114]-[0119]. Sachs describes that a "gesture can be determined to be complete

once a predetermined period of time passes during which no additional large-magnitude pulses are detected." *Id*., [0094].

2. Murakoshi-Stewart-Sachs Combination

a) The Combination

202. Murakoshi discloses that processing the vibratory signals includes converting the signals into vibratory signal components but is silent with respect to how those components are processed. APPLE-1004, [0090] ("The one or more processors may be operable to convert each of the generated one or more vibratory signals into vibratory signal components"), [0014] ("The apparatus may convert each of the generated one or more vibratory signals into vibratory signal components"). Murakoshi describes a system that compares the signal components to determine a vibration frequency associated with the interaction "indicative of an operation associated with the device." *Id.*, [0015]; *see also id.*, [0040] (determining interaction type based on comparison of signal components). Stewart is also silent as to the processing of signals sensed by accelerometers, except to mention that data related to the sensed signals would be processed using processing electronics. APPLE-1006, 1:27-31, 9:66-10:3. Therefore, a POSITA would have been motivated to look to references similar to Murakoshi, such as Sachs, for additional information about how to process vibratory data.

203. Like Murakoshi, Sachs also describes various gestures that a user can make to interact with a device, including tap gestures. APPLE-1007, [0009] ("such functionality can include motion gesture recognition implemented on motion sensing devices to allow a user to input commands or data by moving the device or otherwise cause the device sense the user's motion [f]or example… tapping the device."); [0101] ("A tap gesture typically includes the user hitting or tapping of the device 10 with a finger, hand, or object sufficiently to cause a large pulse of movement of the device in space"). Indeed, the data features described by Sachs are not unique to Sachs, and are common sense features that a POSITA would have known to extract for purposes of comparing to stored values. *See e.g.*, APPLE-1009, Fig. 5, [0014] ("the timing between two occurrences… of high PI are used to distinguish between single and double taps"), [0016] ("timing considerations identify taps and distinguish between single or double taps providing two distinct commands"), [0037] ("a latency timer").

204. Sachs further describes processing gesture data to determine a user's intended instruction, including what types of vibratory signal components a signal would include that would be relevant to determination of a desired user command from the gesture. APPLE-1007, [0102], [0120], [0123], Figs. 11A-B.

205. A POSITA, motivated to combine Murakoshi, Stewart, and Sachs, would have done so by implementing processing of the vibratory signals, per

Murakoshi-Stewart (*see* §IX.A.3 Murakoshi-Stewart Combination), with Sachs' teachings to identify data features including large magnitude pulses, timing between features, and a predetermined period of time following a final feature in order to identify key aspects of the vibratory signals to match to a user command. APPLE-1007, [0094], [0079], [0101]-[0102]. As described above (*supra* §IX.B.1), Sachs' processing method includes identifying these (and other) particular data features in the data signal to compare to stored profiles saves processing power compared to techniques that would compare the entire data signal. *Id.*, [0009]-[0011], [0078]-[0079].

b) Reasons for the Combination

206. A POSITA would have been motivated to pursue the Murakoshi-Stewart-Sachs combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

207. First, a POSITA would have been motivated to implement Murakoshi-Stewart with additional details regarding identifying signal components of tap patterns, per Sachs, based on Murakoshi's own disclosure that the apparatus can be used to map user tap patterns to control signals. APPLE-1004, [0035], [0079]. Murakoshi describes that an apparatus can detect various types of interactions, including "scratching or tapping on the vibratory surface 106 using the object 108, and/or sliding or dragging the object 108 on the vibratory surface." *Id.*, [0022].

Murakoshi further describes that a vibration frequency associated with scratching or tapping the surface can be defined and associated with a control signal and action of a device, but provides few details about detection of the type of interaction (e.g., scratching vs. tapping). *Id.*, [0049]. A POSITA would have understood from Murakoshi's disclosure that other signal components other than a vibration frequency can be mapped to a user command – in particular for the identification and matching of user tap patterns and gestures other than scratching to a user command. A POSITA would have looked to other references like Sachs that provide additional details of how to identify components of vibration data to match a user tap to a command, and would have been motivated to implement Murakoshi-Stewart with Sachs' teachings of signal components to identify for mapping a user input to a desired action so that Murakoshi-Stewart could be used with taps as Murakoshi describes. A POSITA would have understood that Sachs provides additional details as to how to identify vibratory signal components from the vibration data detected at sensors, as in Murakoshi, to determine a type of gesture (such as taps) and the components of the gesture for determining the associated command. APPLE-1004, [0090]; APPLE-1007, [0015], [0079], [0120]-[0123].

208. Second, a POSITA would have been motivated to implement Murakoshi-Stewart to identify large magnitude pulses associated with taps, as

Sachs teaches, to identify user taps on the vibratory surface above any background noise as Sachs teaches. APPLE-1007, [0102]. Sachs describes that "detecting a tap gesture is performed by examining motion sensor data to detect a gesture relative to a background noise floor." *Id.*, [0102], [0084]. "[A]n actual intended tap gesture produces a pulse magnitude 282 far above [the background] noise level 284" when the device including the sensor is held loosely in a user's hand. *Id.*, [0102]. However, when the sensor is located on the surface on which the tap is performed, as in Murakoshi, the "tap gesture produces a much smaller magnitude pulse 290" but still "typically far above the noise level 292." *Id.* Sachs describes that "if the background noise level is considered in the tap detection, tap gestures can be detected more robustly. *Id.* A POSITA would have understood that background noise may interfere with the correct identification of a user input and would therefore have been motivated to use Sachs' teaching to identify signal components corresponding to large magnitude pulses to correctly identify user taps. *Id.*, [0102]-[0104], Figs. 12A-B.

209. Third, a POSITA would have been motivated to implement Murakoshi-Stewart to clearly segment the vibratory signals into components that can be compared to stored or mapped signals. APPLE-1004, [0090]; APPLE-1007, [0079]. Sachs describes that "[i]n order to resolve and process human motion on a device 10, it is necessary to acquire sensor data at high rates," and in

some cases "a sampling rate such as 100 Hz may be needed." APPLE-1007, [0120]. Sachs describes that in an example, a one-second gesture sampled with the 100 Hz sampling rate results in 600 data points[9] but notes that "it is rarely necessary to process all 600 data points, since the human motion can be reduced by extracting important features from the sensor data, such as the magnitude of peaks in the motion waveform, or the particular times of zero crossings." *Id.* By segmenting the vibratory signals into components (as Murakoshi teaches), the identified components (such as the data features that Sachs identifies as useful in determining an intended gesture, such as waveform peaks and timings of features) can be compared to mappings of user inputs to desired commands, rather than comparing the entire signal. *Id.* This not only reduces the processing load by limiting the number of sampled points to be processed and compared, but also allows natural variations in the user's input to be accommodated – for example,

[9] Note however, that Sachs' 600 data points represent sensing with 6 degrees of freedom. *See* APPLE-1007, [0120]. The same sampling rate applied to the Murakoshi-Stewart-Sachs system would have fewer degrees of freedom, and thus fewer data points to be sampled, but Sachs' conclusion that processing all sampled data points is unnecessary remains true.

minor differences in timing of inputs can be tolerated and the correct command can be identified. *Id.*, [0015], [0078]-[0080], [0120].

210. Fourth, a POSITA would have been motivated to implement Murakoshi-Stewart to identify timing between features, as Sachs teaches, to provide flexibility in recognition of gestures while still distinguishing between different user commands. APPLE-1007, [0079]. As I've explained above, different users may perform gestures with slightly different timings, and indeed even the same user would find it difficult to perform a gesture in the same exact manner each time. Sachs recognizes that solutions that "hard-code or train all possible variations of a gesture" are "expensive in processing time and difficult to implement." *Id.*, [0010]; *see also id.*, [0078] ("If the required timing values are hard-coded, then many different ranges of values will need to be stored, and it will be difficult to cover all possible user variances and scenarios"). Sachs describes a system that "recognizes gestures using relative timing requirements" by measuring the time period between identified data features (e.g., between peaks) and using the measured time to recognize a particular gesture. *Id.*, [0078]-[0079]. As described above, measuring timing between data features provides an important feature for identifying a particular feature and allows a user to have the desired effect on controlling a terminal device, despite imperfections or deviations from a mapped input.

211. Fifth, a POSITA would have been motivated to implement Murakoshi-Stewart to clearly signal that the user tapping gesture is completed as Sachs teaches so that it can be determined when a user input is finished and can be matched to a user intended command. APPLE-1007, [0079]. A POSITA would have understood that it is important to provide a period of time following the last detected data feature (or other gesture end mechanism) to determine the end of a gesture. Such a predetermined period of time following a detected gesture would allow for the determination that a gesture is a single or double tap, allow for identifying the end of a scratching pattern, or allow for differentiation between various gestures that form shapes or letters. APPLE-1007, [0107]-[0109] (explaining gestures including a circle gesture, letters, numbers or other symbols); APPLE-1004, [0035] ("Examples of the gesture may include, but are not limited to, drawing s shape and/or drawing an alphanumeric character"), [0050] (explaining that a user may interact with the vibratory surface by drawing a circle or other gesture on the surface), [0074]-[0075] (describing a user drawing letters on the vibratory surface). For example, a POSITA would have been motivated to implement Murakoshi-Stewart's system with Sachs' teaching to wait a period of time following an impact to determine whether the user gesture includes an additional impact (e.g., a single or double tap). APPLE-1007, [0112] ("For example, three shake gestures may be required to be detected, in succession, to

detect the three as a single gesture and to implement the function(s) associated with the shake gesture [or in another example] three tap gestures may be required to be detected instead of just one.").

212. Sixth, a POSITA would have understood that implementing Sachs' teachings to identify features of the vibratory signals such as large magnitude pulses, timing between features, and a time period following a final input in the context of Murakoshi-Stewart would have yielded predictable results from combining known elements according to known methods. As Sachs describes, the identification of patterns in sensed data to be used to identify a gesture and associate the gesture with a desired response or command was well-known and there were various methods for identifying patterns in the data. In particular, Sachs describes that "[p]rior gesture recognition for motion sensing devices typically consist[ed] of examining raw sensor data such as data from gyroscopes or accelerometers, and either ***hard-coding patterns to look for*** in this raw data, or using machine learning techniques (such as neural networks or support vector machines) ***to learn patterns from this data***." APPLE-1007, [0009] (emphasis added). A POSITA would have understood that Murakoshi's system also incorporates identification of patterns in the data (i.e., to determine a vibration frequency) for identifying a gesture and using stored data to look up an associated command. APPLE-1004, [0015], [0047] ("the processor 202 may determine a

vibration frequency that corresponds to each of the one or more vibratory signals generated by the sensor 206… [t]he determined vibration frequency is indicative of an operation associated with the device 102"), [0048] ("The processor 202 may generate the control signal based on the determined vibration frequency…the processor 202 may determine a control signal that corresponds to the determined vibration frequency based on frequency-operation mapping data stored in the memory 204 [which] may specify an operation of the device 102 to be controlled in response to a vibration frequency of a vibratory signal"). A POSITA would have understood that Sachs' teachings merely provide additional data features that can be extracted from vibratory data signals to enable mapping of a gesture to a desired command. Given these similarities between Murakoshi's and Sach's teachings, a POSITA would have further had a reasonable expectation of success in the combination.

213. Additionally, a POSITA would have appreciated that both Murakoshi and Sachs describe systems that receive user inputs and process the inputs to determine an associated user intended command to control another device. APPLE-1004, Abstract, [0047]-[0048], [0077]; APPLE-1007, Abstract, [0079]. Because both references are related to the processing of gesture data to determine an intended gesture and associated action, a POSITA would have understood that the teachings of the references could be combined and would have had a

reasonable expectation of success in doing so. Further, both Murakoshi and Sachs describe similar types of gestures including tapping (*see e.g.*, APPLE-1004, [0034], [0049]; APPLE-1007, [0101]-[0105]) and more complex gestures such as shapes and characters (*see* APPLE-1004, [0035], [0050], [0078]; APPLE-1007, [0108]-[0110]). Because the types of gestures described are the same or similar, a POSITA would have been confident that the types of data features that Sachs teaches as being components of a data pattern for identifying a gestures could be applied in Murakoshi-Stewart's system and thus had a reasonable expectation of success in the combination. In the combination, each element performs a similar function as it does in the reference – that is, the apparatus detects vibrations as described above in the Murakoshi-Stewart combination, and processing occurs at the processor as described above, and the processor processes the data with the teachings of Sachs to identify particular additional data features for mapping the data signal to a gesture. In particular, because the combination relies on the combination of the teachings of the references rather than bodily incorporation, a POSITA would have understood that Sachs' teachings that particular data features are useful in identifying a user gesture without using unnecessarily large amount of computing power could be implemented in processing data signals of the apparatus, per Murakoshi and Stewart, further evidence of a reasonable expectation of success in the combination.

214. Applying and combining these concepts would have been obvious from a POSITA's perspective, at least because processing of vibration data to extract impact and timing information was well-known by the Critical Date, as described above. Augmenting a processor to identify data features taught by Sachs would have been well within a POSITA's skill level. A POSITA would have expected that identifying the additional data signal components described by Sachs could be accomplished by simply adding additional parameters and thresholds to the instructions executed by a processor, per Murakoshi. Applying and combining these concepts would have been obvious from a POSITA's perspective, and a POSITA would have had a reasonable expectation of success in doing so for all of the above reasons.

3. Element-by-Element Analysis

a) Claim 1

[1pre]-[1c-v], [1d-i]-[1e]

215. Murakoshi-Stewart-Sachs renders obvious elements [1pre]-[1c-v] and [1d-i]-[1e] for the same reasons as described above for claim 1 under Ground 1A. *Supra* §§IX.A.4.[1pre]-[1c-v], [1d-i]-[1e] (Ground 1A). Because Sachs provides additional details related to the processing of vibratory signals, mappings to claim elements that are not related to the specifics of the processing method are not altered from the mappings described above. For example, the claimed structures of

the housing and accelerometer, functions of the accelerometer, and the components of the server are not altered. Sachs' additional signal processing details are relevant only to the mapping of the processing module function, as I will explain below.

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and

216. Under Haptic's apparent understanding of this limitation (§VIII Claim Construction; *see also* APPLE-1101), Murakoshi-Stewart-Sachs renders this limitation obvious at least because Sachs discloses a motion gesture detection system in which "[m]otion gesture(s) are recognized from the motion data from a set of motion gestures available for recognition in the active operating mode." APPLE-1007, Abstract; §IX.B.2 (Murakoshi-Stewart-Sachs Combination). Sachs describes that "[t]he use of data features in motion sensor data allows gestures to be recognized with reduced processing compared to processing all motion sensor data." *Id.*, [0015], Fig. 9. A POSITA would have understood that Sachs' data features are equivalent to the claimed "data pattern" because they correspond to the motion data detected by the sensors during a user gesture (i.e., data signals of the contact interaction).

217. Sachs describes that "gesture recognition allows a user to easily select particular device functions by simply moving, shaking, or tapping the device [and

p]rior gesture recognition for motion sensing device typically consists of examining raw sensor data such as data from gyroscopes or accelerometers, and either hard-coding patterns to look for in this raw data, or using machine learning techniques… to learn patterns from this data." APPLE-1007, [0009]. A POSITA, reading Sachs, would have understood that matching data from a user gesture to an intended action or command requires comparison of some pattern – whether the "pattern" comprises the whole amount of raw data (as Sachs describes some prior art systems did) or identifying relevant portions of the data as the "pattern" for ease of comparison. *Id.* Sachs describes that the motion data associated with a user gesture is examined to detect a particular gesture (contact interaction) and that it is known to use patterns (data patterns) of the motion data (data signals) to match the user motion to an associated gesture (gesture profile) and command. APPLE-1007, [0009]-[0010], [0015], [0101].. Sachs goes on to describe the particular data features that are useful to identify in the data signals for accurate detection of a particular gesture. APPLE-1007, [0123], [0126]. Sachs' data features are used as the data pattern associated with a gesture for "varied, robust and accurate gesture recognition" and matching of the gesture to the intended command. APPLE-1007, [0011], [0010], [0015], [0079].

218. Accordingly, under Haptic's apparent understanding of the claim term "processing module" (§VIII Claim Construction), in the Murakoshi-Stewart-Sachs

combination, a processor (processing module) determines a pattern (data pattern) corresponding to vibratory signals (data signals) from the interaction of an object with the vibratory surface (contact interaction), per Murakoshi, using Sachs' teachings to identify important data features to match the pattern of data features to a gesture and associated command. APPLE-1007, [0009]-[0010], [0015], [0101], Fig. 9; APPLE-1004, [0013], [0038], [0015], [0023], [0025], [0027], [0036], [0048], Fig. 1.

b) Claims 2, 8-9

219. Murakoshi-Stewart-Sachs renders obvious claims 2, 8 and 9 for the same reasons described above with regard to Ground 1A. *Supra* §§IX.A.4.[2], [8], [9] (Ground 1A). For the same reasons explained above, the mappings of claims 2, 8 and 9 are not altered by the addition of Sachs to the combination, because Sachs provides additional details related to the processing of vibratory signals. Accordingly, mappings to claims that are not directly related to the specifics of the processing method are not altered from the mappings described Ground 1A.

c) Claim 4

[4a] The control system, according to claim 1, wherein said contact interaction is comprised of an impact on said mounting surface,

220. Under Haptic's apparent understanding of the claim limitation (§VIII Claim Construction), Murakoshi discloses this element. *Supra* §IX.A.4.[1b-vii] (Ground 1A). In particular, Murakoshi describes that "a user may scratch and/or

tap at any location on the vibratory surface 106 using the object 108, such as the nail of the finger." APPLE-1004, [0035] (emphasis added).

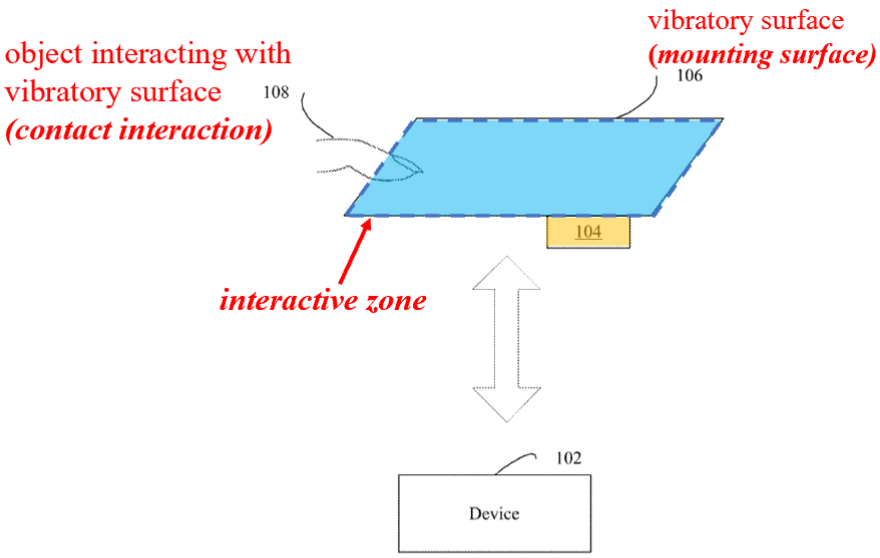


FIG. 1

APPLE-1004, Fig. 1 (annotated) (modified)

221. A POSITA would have recognized Murakoshi's description of a tap on the vibratory surface to be "an impact" on the mounting surface. *See e.g.*, APPLE-1047 ("A tap is simply a synonym for a light strike, pat or rap that causes an object to undergo acceleration."); APPLE-1007, [0101] ("A tap gesture typically includes the user hitting or tapping of the device 10 with a finger, hand, or object").

[4b] said data signals having a respective defined peak corresponding to each impact, a defined time period after a last defined peak, said data pattern being comprised of each defined peak and said defined time period after said last defined peak.

222. In the Murakoshi-Stewart-Sachs combination, Murakoshi's vibratory signals are processed according to the processing methods described by Sachs to determine data features that define the gesture. Sachs' processing technique includes identifying data features including large-magnitude pulses associated with the interaction (respective defined peak corresponding to the impact) and a predetermined period of time after an interaction (a defined time period after a last defined peak) for determining that the gesture is complete. §IX.B.2 (Murakoshi-Stewart-Sachs Combination); APPLE-1007, [0101]-[0102], [0094].

223. For example, Sachs describes that the raw data associated with a tap gesture includes a large magnitude pulse which is detected above the background noise floor (a defined peak corresponding to the impact). *Id*., [0102]. Regarding Figs. 11A and 12A, Sachs describes that the figures "include[] a detected tap pulse 282 shown as a large magnitude pulse." *Id.*

224. Sachs also describes that the raw data associated with a gesture can include a predetermined period of time following the gesture during which no additional large-magnitude pulses are detected. APPLE-1007, [0094]. For example, "[a] shaking gesture can be determined to be complete once a predetermined period of time passes during which no additional large-magnitude

pulses are detected." *Id.* A POSITA would have recognized that the predetermined period of time for determining the completion of the gesture is applicable to any gestures used to convey user instructions, including the tapping gestures of Murakoshi-Stewart-Sachs. §IX.B.2 (Murakoshi-Stewart-Sachs Combination). As described above, a POSITA would have understood that it is important to provide a period of time following the last detected data feature (or other gesture end mechanism) to determine the end of a gesture. Such a predetermined period of time following a detected gesture would allow for the determination that a gesture is a single or double tap, allow for identifying the end of a scratching pattern, or allow for differentiation between various gestures that form shapes or letters. APPLE-1007, [0107]-[0109] (explaining gestures including a circle gesture, letters, numbers or other symbols); APPLE-1004, [0035] ("Examples of the gesture may include, but are not limited to, drawing s shape and/or drawing an alphanumeric character"), [0050] (explaining that a user may interact with the vibratory surface by drawing a circle or other gesture on the surface), [0074]-[0075] (describing a user drawing letters on the vibratory surface).

225. As described above in Element [1c-vi], Murakoshi discloses that the processor determines features of the vibratory signal in order to generate a control signal corresponding to the generated vibratory signals. §IX.B.3.[1c-vi] (Ground 1B); APPLE-1004, [0038] ("[t]he processor 202 may be operable to convert each

of the generated one or more vibratory signals into vibratory signal components"), [0015]-[0016], [0036]-[0038], Figs. 1A-C. Sachs describes the identification of particular data features in the gesture data detected by a sensor for use in determining a matching user command, such as a large magnitude pulse and a predetermined period of time following a final pulse or peak in the data. APPLE-1007, [0009], [0094], [0102]; *see* §IX.A.1 (Summary of Sachs). A POSITA would have understood that Murakoshi-Stewart-Sachs uses details of the detected vibratory signals, including the features taught by Sachs such as defined peak and defined time period, as a data pattern to be matched to an established pattern associated with a user commands. APPLE-1004, [0013], [0018], [0036], [0048]-[0049]; APPLE-1007, [0009], [0094], [0102]; §IX.B.2 (Murakoshi-Stewart-Sachs Combination). As described above, by identifying data features in the sensed data for detection of a user gesture, the computational resources required for processing the data and matching the data can be minimized so that gestures can be efficiently identified. APPLE-1007, [0015], [0078]-[0080], [0120]; §IX.B.2 (Murakoshi-Stewart-Sachs Combination).

d) Claim 5

[5a] The control system, according to claim 1, wherein said contact interaction is comprised of a plurality of impacts on said mounting surface,

226. Murakoshi-Stewart-Sachs renders claim 5 obvious for the same reasons as discussed above with regard to claim 4 and for the following reasons.

Element [5a] of claim 5 is similar to Element [4a] of claim 4 ("wherein said contact interaction is comprised of an impact on said mounting surface") but requires a plurality of impacts instead of a single impact. The Murakoshi-Stewart-Sachs combination provides multiple impacts. Murakoshi discloses that the interaction of the object with the vibratory surface (contact interaction) can be tapping to create multiple vibratory signals (a plurality of impacts) on the vibratory surface (on said mounting surface). APPLE-1004, [0050] ("To perform the gesture, a user may perform ***a plurality of interactions*** at a plurality of locations ***on the vibratory surface 106***") (emphasis added), [0015] ("apparatus may determine a vibration frequency corresponding to each of the generated one or more vibratory signals"), [0022], [0035]. Sachs also describes gestures comprising multiple impacts. APPLE-1007, [0112] ("three tap gestures").

227. As described above, a POSITA would have recognized Murakoshi's description of a tap (or Sachs', for that matter) on the vibratory surface to be "an impact" on the mounting surface. *See e.g.,* APPLE-1047 ("A tap is simply a synonym for a light strike, pat or rap that causes an object to undergo acceleration."); APPLE-1007, [0101] ("A tap gesture typically includes the user hitting or tapping of the device 10 with a finger, hand, or object").

[5b] said data signals having a respective defined peak corresponding to each impact, a measured time period between each defined peak, and a defined time period after a last defined peak, said data pattern being comprised of each defined peak, each measured time period, and said defined time period after said last defined peak.

228. Limitation [5b] of claim 5 includes the features of limitation [4b] of claim 4 (a respective defined peak corresponding to each impact, a defined time period after a last defined peak), and adds an additional data feature (a measured time period between each defined peak). Murakoshi-Stewart-Sachs renders obvious the shared features (a respective defined peak corresponding to each impact, a defined time period after a last defined peak) for the same reasons described above in Element [4b]. *Supra* §IX.B.3.[4b] (Ground 1B); APPLE-1007, [0101]-[0102], [0094].

229. Additionally, with regard to the "measured time period between each defined peak," Sachs describes that a flexible recognition of gestures can rely on identification of data features including the timing between different features in the gesture motion data (a measured time period between each defined peak). APPLE-1007, [0079]. Sachs describes that "the timing between different features in motion data can be expressed and detected based on multiples and/or fractions of a basic time period used in that gesture… [t]he basic time period can be, for example, the time between two data features." *Id.* As explained above, detecting a timing between features (such as peaks), allows for easier comparison of the

gesture data to mapped gestures to identify the intended gesture without excessive use of computational resources. *Id*., [0078]-[0079], [0096], [0126]-[0127]; §IX.B.2 (Murakoshi-Stewart-Sachs Combination).

230. Further, Murakoshi-Stewart-Sachs renders obvious that the data pattern includes these data features identified by Sachs for the same reasons described above in Element [4b]. *Supra* §IX.B.3.[4b] (Ground 1B); APPLE-1007, [0101]-[0102], [0094], [0009]; APPLE-1004, [0013]-[0018], [0036]-[0038], Figs. 1A-C. It would have been obvious to a POSITA to use the identified data features, including the measured time period between gestures, defined peaks and defined time period after the last defined peak, described by Sachs as a data pattern for comparison to stored gestures to determine a user command associated with a gesture. §IX.B.2 (Murakoshi-Stewart-Sachs Combination).

e) Claim 10

[10pre]-[10l]

231. Murakoshi-Stewart-Sachs render claim 10 obvious for the same reasons described above in Ground 1A, and for the reasons described above with regard to claim 1 in Ground 1B. In particular, because Sachs provides additional details related to the processing of vibratory signals, mappings to claim elements that are not related to the specifics of the processing method are not altered from the mappings described above. For that reason, at least claim elements [10pre]-

[10h] and [10k-i]-[10l] are rendered obvious by Murakoshi-Stewart-Sachs for the same reasons explained above in Ground 1A – these elements do not incorporate the functions of the processing module and the mappings of these elements are unaltered by the addition of Sachs. *Supra* §§IX.A.4.[10pre]-[10h], [10k-i]-[10l] (Ground 1A). Regarding claim elements [10i] (determining a data pattern corresponding to said data signals of said contact interaction with said processing module) and [10j] (matching said data pattern to a gesture profile with said processing module, said gesture profile being associated with a command), these elements recite the same or similar limitations as claim element [1c-vi] (said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command), and these claim elements are rendered obvious by Murakoshi-Stewart-Sachs for the same reasons explained above with regard to claim element [1c-vi] in this ground, Ground 1B. *Supra* §§IX.B.3.[10i]-[10j] (Ground 1B).

f) Claim 11

[11] The method of controlling the terminal device, according to claim 10, wherein the step of making a physical impact on said mounting surface further comprises making a plurality of physical impacts on said mounting surface, said contact interaction being associated with more than one physical impact.

232. Murakoshi-Stewart-Sachs renders this element obvious for the same reasons described above with regard to element [5a] of claim 5. *Supra*

§IX.B.3.[5a] (Ground 1B). Claim 11 requires that the physical impact on the mounting surface is a plurality of physical impacts. As explained above with regard to claim 5, Murakoshi and Sachs both make clear that a user can make a gesture that includes a plurality of impacts (e.g., taps) on a surface. APPLE-1004, [0050] ("To perform the gesture, a user may perform ***a plurality of interactions*** at a plurality of locations on the vibratory surface 106"); APPLE-1007, [0112] ("three tap gestures may be required to be detected instead of just one").

C. GROUND 1C: THE MURAKOSHI-STEWART-SACHS-ORR COMBINATION RENDERS CLAIMS 1-2, 4-5, AND 8-11 OBVIOUS

233. Discussion below covers Ground 1C under Apple's constructions. §VIII (Claim Construction).

1. Orr

234. Orr is directed to "systems and processes for using a virtual assistant to control electronic devices." APPLE-1005, Abstract. Orr describes that "a virtual assistant can be implemented according to a client-server model." *Id.*, [0027]. "The virtual assistant can include a client-side portion executed on a user device 102, and a server-side portion executed on a server system 110." *Id.*; *see also id.*, [0031]. Orr describes that "[s]erver system 110 can be implemented on one or more standalone data processing devices or a distributed network of computers." *Id.*, [0029].

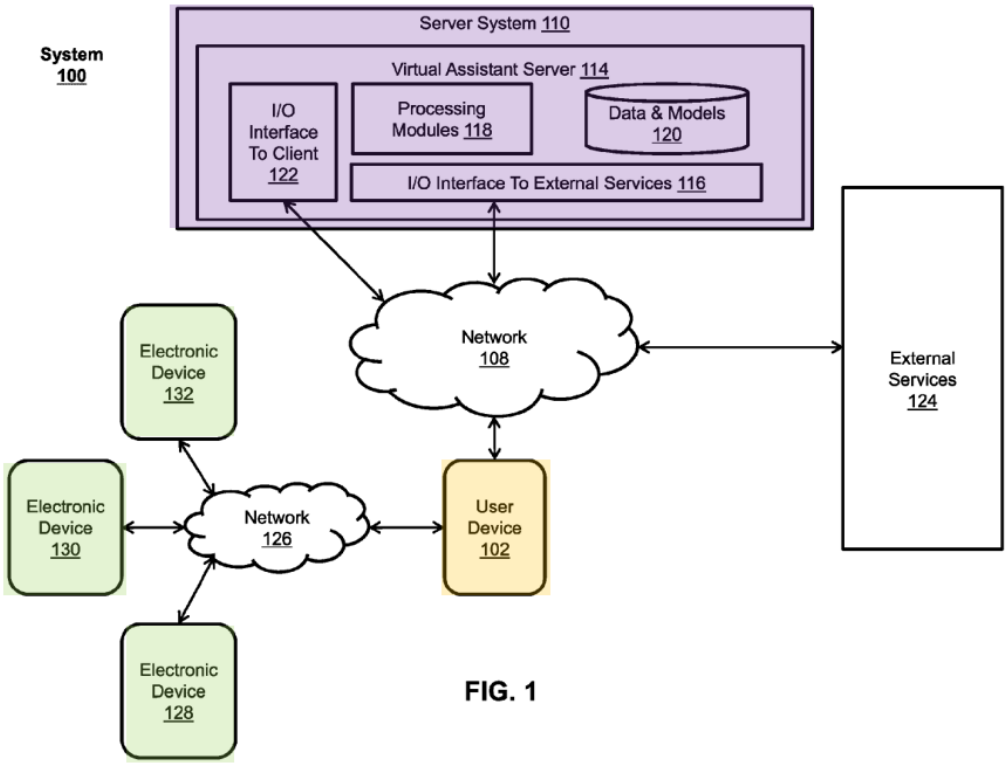


FIG. 1

APPLE-1005, Fig. 1 (annotated)

235. Orr's virtual assistant user device detects user speech, and "[t]he user device can transmit the user speech to a server to be converted into a textual representation." *Id.*, [0005]. "The server can identify the one or more electronic devices and appropriate commands to be performed by the one or more electronic devices based on the textual representation [and t]he identified one or more devices and commands to be performed can be transmitted back to the user device, which can forward the commands to the appropriate one or more electronic devices for execution." *Id.* "In response to receiving the commands, the one or more

electronic devices can perform the commands and transmit their current states to the user device." *Id.*

2. The Combination of Murakoshi-Stewart-Sachs and Orr

a) The Combination

236. Murakoshi's apparatus 104 includes "one or more processors, such as a processor 202, a memory 204, one or more sensors, such as sensor 206, an analog to digital converter 208…, a receiver 210, and a transmitter 212." APPLE-1004, [0025], Fig. 2. Although Murakoshi discloses that the apparatus includes logic and circuitry for processing the vibratory signals received from the sensors, it would have been obvious to a POSITA to use a server for processing the vibratory signals associated with the user's tapped or scratched commands to access greater processing power of Murakoshi's frequency domain transformations for improved efficiency. APPLE-1004, [0027], [0015], [0018], [0013], [0016]. The use of an external server, for example, a cloud-based server, was well-known by the Critical Date and was often used to process data to make use of expanded processing power at the server and to separate the data processing from other functions being performed at the device. A POSITA would have understood that in some situations, transmitting data from a device to a server for processing would have reduced the requirement for intensive processing systems at the device.

237. A POSITA would have appreciated that Murakoshi's processing of vibrations resulting from a user tapping and scratching the vibratory surface could represent a heavy processing load, and would have looked to similar references related to processes for determining an intended user command from a user input, such as Orr. APPLE-1004, [0042]-[0049]. In particular, Murakoshi describes a system capable of detecting user taps and scratches (or various other interactions) at different locations on a surface and interpreting the resulting vibrations to determine an intended command based on the user action and location. *Id*., [0022]-[0023]. For example, Murakoshi describes that "[t]he apparatus 104 may generate a control signal to switch on a lamp placed on the table when a user may scratch on the center of the table [and] a control signal that corresponds to scratching near the corners may switch off the lamp." *Id*., [0023]. Murakoshi further describes that the user can interact with the surface using the finger or finger nail and that the user can perform gestures including drawing shapes or characters on the surface. *Id*., [0035]. A POSITA would have appreciated that differentiating between these different user inputs could require heavy processing capabilities and would have been motivated to look for ways to accomplish this processing without requiring Murakoshi's apparatus to house a bulky processing system.

238. Orr teaches that "a virtual assistant can be implemented according to a client-server model" with "a client-side portion executed on a user device" and "a server-side portion executed on a server system." *Id.*, [0027]. Orr's server can be external to the device (*see* APPLE-1005, [0027], Fig. 1) or "implemented on one or more standalone processing devices." APPLE-1005, [0029]. A POSITA would have understood that servers can be implemented as cloud-based, external servers, or a device can be implemented to itself act as client and server. A POSITA would have understood that each of these options has associated benefits and disadvantages and it would have been well within a POSITA's skill level at the Critical Date to select between these two options. For example, a POSITA would have selected to implement Murakoshi's teachings with an external cloud-based server, per Orr, for processing the vibration data because Murakoshi's apparatus would be used in a home environment (at least in some situations) where access to a wi-fi or internet signal would not be an issue and would allow for more intensive processing of the data without increasing a size of Murakoshi's apparatus to accommodate additional processing systems.

239. Orr further teaches that the server can process user inputs to determine an intended user command to control a device and can provide an instruction to the device. *Id.*, [0005]. Thus, it would have been obvious in view of Orr to implement Murakoshi's system with processing of vibrational signals taking place at a server,

to take advantage of the benefits described in this section such as increased processing power without increasing a size of Murakoshi's apparatus, and still be able to determine a user's intended command (and corresponding control signal) and transmit the control signal to the device. *See* APPLE-1004, [0053]-[0054] (describing the apparatus processor interacting with an registering multiple devices that can be controlled by user interactions with the surface)

240. A POSITA, motivated to combine Murakoshi-Stewart-Sachs with Orr, would have done so by using a server to process the vibratory signals from the Murakoshi's sensor to determine an intended command associated with the user tapping or scratching. APPLE- 1004, [0036]; APPLE-1005, [0027], [0029], Fig. 1. A POSITA would have understood that the routing, processing, and outputting activities that Murakoshi describes as occurring at the apparatus may also be carried out at Orr's server to process user inputs to determine an intended command. *See* APPLE-1005, [0028].

b) Reasons for the Combination

241. A POSITA would have combined Murakoshi and Orr to use an external cloud-based server, as Orr teaches, to process vibratory signals, per Murakoshi. APPLE-1005, [0027], [0029], [0031]; APPLE-1004, [0025]-[0028]. Implementing a vibration-detecting apparatus, as Murakoshi teaches, with Orr's teaching to process user input data at a cloud-based server would have enabled off-

site processing of the vibration data to decrease processing power required by the apparatus.

242. This use of a server for carrying out processing steps already performed in Murakoshi's apparatus would have been well within a POSITA's skill level, and thus, implemented with a reasonable expectation of success. A POSITA would have understood that to perform the processing at the server, the vibration data detected at the sensor is transmitted to the server, rather than to a processor internal to Murakoshi's apparatus. A POSITA would have also been aware of the use of external servers to process data by the Critical Date, and that it was typical to offload data processing to a server where large volumes of data need to be processed or where particularly intensive processing of the data is required. A POSITA would have been readily able to utilize a server for processing of vibratory signals, as Orr describes. A POSITA would have been aware of various server-processing services that were available by the Critical Date, and would have been able to implement the processing described by Murakoshi and Sachs at a server. *Supra* §IX.B.2 (Murakoshi-Stewart-Sachs Combination).

243. A POSITA would have been motivated to pursue the Murakoshi-Stewart-Sachs-Orr combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

244. First, a POSITA would have recognized that additional processing power may be accessible with the user of an external cloud-based server and would have appreciated that additional processing power would be useful for processing user inputs such as scratching. APPLE-1004, [0022]-[0023], [0035]. In particular, processing of the vibrational signals to determine "the type of the interaction" between a user and a surface (e.g., from among the options of scratching with a fingernail, dragging a fingernail, dragging the skin of the fingertip, tapping, etc.) and the location of the interaction could require heavy processing. *Id*., [0045]-[0047]. A POSITA would have understood that such processing may be better offloaded to an external server for a variety of reasons, including accessing the additional processing power at a server.

245. For example, a POSITA would have recognized that frequency domain analysis of vibratory signals associated with a user scratching at the vibratory surface, per Murakoshi, could have required heavy processing that could be accomplished more quickly at an external server. APPLE-1004, [0015], [0042]-[0049], [0077]-[0079]. Murakoshi describes that "the processor 202 may determine a vibration frequency that corresponds to each of the one or more vibratory signals generated by the sensor 206" based on a variety of inputs including "a material of the vibratory surface 106, a type of the object 108, a type of the interaction, and/or a roughness of the vibratory surface 106." *Id.*, [0047]. A

POSITA would have understood that determining a vibration frequency of the signal and identifying the details of the interaction to indicate a user command would require intensive processing. Such processing could also require substantial memory if, for example, the signal analysis was based on a machine learning approach. Similarly, if a processing approach required a significant amount of memory, that would have provided an additional motivation to execute the processing on an external server where more memory may have been available.

246. Second, a POSITA would have been motivated to implement the Murakoshi-Stewart-Sachs-Orr combination ("Murakoshi-Stewart-Sachs-Orr") to use a server for processing of the sensor signals, as Orr teaches, to accomplish separation of concerns so that the applications processing and matching user commands could be separately maintained and updated from applications associated with the accelerometer.

247. It was well-known by the Critical Date that a server could be used for offloading processing of data from a local processor. Doing so would not only reduce the local processing power required on the device, but would also achieve the engineering principle of "separation of concerns."

248. Over the years, the field of software engineering has developed a number of standard technical approaches to structuring software to make computing systems more reliable and easier to develop. APPLE-1043, 1. A key

such principle is called "separation of concerns" which refers to the idea that by separating the components of a technical system and minimizing the coordination between them, each can be developed, tested, and updated separately from each other. APPLE-1044, 2; APPLE-1042, 1; APPLE-1045, 1, 2-3. "Separation of concerns is at the core of software engineering, and has been for decades… it refers to the ability to identify, encapsulate, and manipulate only those parts of software that are relevant to a particular concept, goal, or purpose." APPLE-1043, 1. This decreases cost and complexity while increasing reliability. APPLE-1044, 2, 11; APPLE-1042, 1. This principle is applied in innumerable places that are often quite visible (e.g., changing the tires on your car does not require you to change the wheels that the tires are mounted on). In computer systems, this principle lets you upgrade your operating system without having to change your personal documents.

249. One application of the "separation of concerns" principle is in the separation of the specific sensing technology from an application's use of a touch sensor. In my own experience building Pad++, the application code needed to know what portion of the screen a person indicated, but it did not matter how the person indicated that position. In fact, I would sometimes use a mouse, a capacitive touch screen sensor or a resistive touch screen sensor without changing a single line of application code – because the code was completely unaware of the sensing

technology. This separation of concerns was both common and a standard best practice of software engineers.

250. Third, a POSITA would have further been motivated to implement Murakoshi-Stewart-Sachs-Orr with an external server to decrease the size of the apparatus, because if processing is taking place at an external server, a smaller sized processor might be all that is required within the apparatus. A POSITA would have understood that removing intensive processing procedures from the apparatus would mean that the apparatus may be implemented with a smaller processor, allowing for a smaller form-factor of the apparatus housing. A smaller apparatus housing would be desirable for design purposes, as the apparatus would take up less space on the vibratory surface (e.g., a tabletop) and would leave more space for the surface to be used for providing user gestures or for the user to treat as a table (e.g., by placing other objects on the table). Additionally, a smaller apparatus housing may be more easily disguised to blend in with a home environment and a user's decorating tastes.

251. Fourth, a POSITA would have understood that using an internal processor or using an external server are two options for processing signals and would have been capable of selecting between these two suitable options. A POSITA would have understood that the processing of the vibratory signal from Murakoshi's sensor can be accomplished in a variety of ways that can be

implemented in either a processor located in the housing, or in a server external to the housing. As described above, a POSITA would have understood that each option presents challenges and benefits, for example, related to accessibility/reliability of wifi or another internet connection, cost associated with use of server processing services, benefits in terms of separation of concerns that allow for separate maintenance of processing services and other functions of the apparatus (for example, user-facing GUIs), or other considerations. A POSITA would have been well aware of the various considerations in determining where to implement the processing for Murakoshi's vibration detection apparatus, and would have understood that both implementing at a processor in the apparatus (as Murakoshi teaches) or implementing in a cloud-based server (as Orr teaches) would have been suitable options, depending on the specific considerations that a POSITA wanted to achieve. It would have been well within a POSITA's skill level to select between these two suitable options, and a POSITA would have selected implementing the processing in a cloud-based server in at least some situations.

252. Fifth, a POSITA would have understood that implementing Orr's teachings to use a server for processing of user inputs to a virtual assistant in the context of a tap-input apparatus, per Murakoshi, would have yielded predictable results from combining known elements according to known methods. As

described above, the use of cloud-based servers for processing data was well-known by the Critical Date, as were devices that receive user inputs and determine an intended command from the inputs. *Supra* §VI.B.2. Implementing the processing details described by Murakoshi and Sachs (*see supra* §IX.B.2 (Murakoshi-Stewart-Sachs Combination)) in a cloud-based server, per Orr, would have required simply implementing the processing algorithm in a server instead of a processor and transmitting the vibration signal from the apparatus to the server for processing. A POSITA would have understood that the location of the processing does not substantively alter the processing algorithm being applied.

253. Both references describe systems that receive user inputs as process the inputs to determine an associated user intended command to control another device. APPLE-1004, Abstract, [0047]-[0048], [0077]; APPLE-1005, Abstract, [0023], [0027]. Accordingly, a POSITA would have understood that the teachings of Orr regarding processing of signals from user inputs at a server are applicable to Murakoshi-Stewart-Sach's system, and that the system would operate as expected when implemented with the processing at a cloud-based server. Each element in the combination performs a similar function as it does separately. For example, the structure of the accelerometer described by Murakoshi is not altered by the combination, only the signal detected by the accelerometer is transmitted from the sensor to the I/O interface of the server so that it can be processed at the server.

Thus, a POSITA would have had a reasonable expectation of success in the combination. Additionally, the terminal device described by Murakoshi is not altered by the combination; it just receives the control signal from the server after the server processes the vibration data signal to determine an intended control signal. Applying and combining these concepts would have been obvious from a POSITA's perspective, and a POSITA would have had a reasonable expectation of success in doing so for all of the reasons above.

3. Element-by-Element Analysis

a) Claim 1

[1pre] A control system comprising:

254. For the same reasons as described above in Ground 1A, to the extent that the preamble is limiting, Murakoshi discloses it. §IX.A.4.[1pre] (Ground 1A). As described above, Murakoshi discloses "an apparatus and method ***for controlling*** a user interface of a device" and thus renders obvious a control system. APPLE-1004, [0002] (emphasis added), [0005], [0013], [0016], Fig 1.

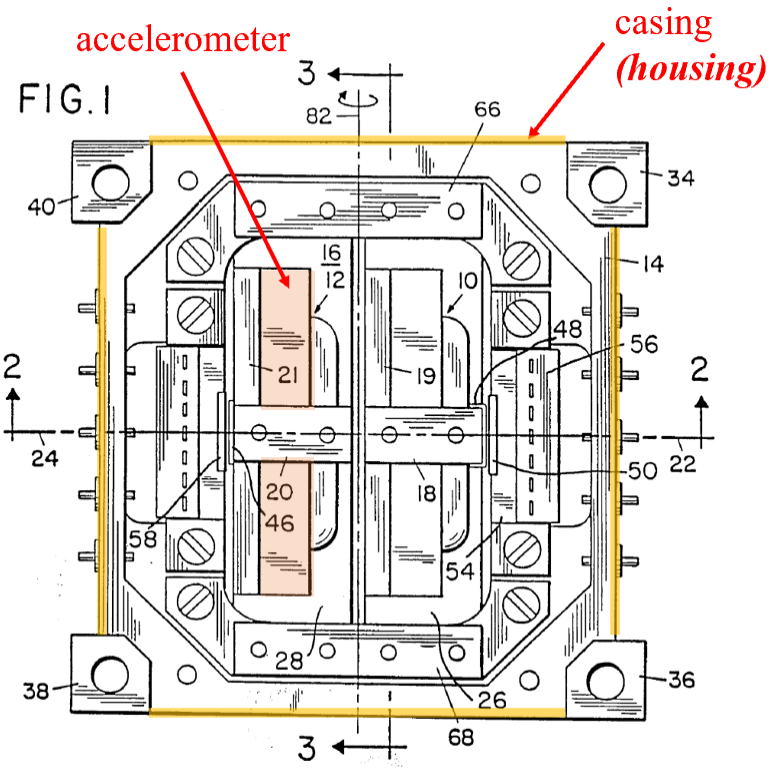
[1a] a housing having an engagement means for a mounting surface;

255. Under Apple's construction, the term "engagement means" is interpreted as a means plus function term that includes the functions described in element [1e]. In full, the "engagement means" term reads " engagement means … wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion

connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion." Accordingly, to address this claim limitation fully, various claim elements that are discussed more fully in element [1e] and other elements of the claim need to be introduced, albeit briefly (for example, the sensor which is fully addressed in element [1b-ii] is briefly introduced here). I provide sub-headers to guide the reader through this analysis below.

housing

256. Murakoshi-Stewart-Sachs-Orr provides an apparatus implemented with the teachings of Stewart to position the accelerometer within a casing (housing). APPLE-1006, 5:8-9, Fig. 1; §IX.C.2 (Murakoshi-Stewart-Sachs-Orr Combination).



APPLE-1006, Fig. 1 (annotated)

housing attached to a mounting surface

257. Murakoshi discloses an apparatus coupled to a vibratory surface (mounting surface). APPLE-1004, [0021]. Murakoshi discloses that "[t]he apparatus 104 may be fixed above and/or below the table top." *Id.*, [0021]. Under Apple's construction, the Murakoshi-Stewart-Sachs-Orr apparatus is coupled to the top of the vibratory surface (mounting surface). §VIII (Claim Construction). As described above, this construction is consistent with the treatment of the claim limitation "said contact interaction being comprised of an impact on said mounting surface" (*supra* §IX.C.3.[1b-vii]) during prosecution of the application, when the

patent owner made clear that the claimed contact interaction must be made directly on the mounting surface. *See* APPLE-1002, 103-104, 133, 142-145. As a result, the mounting surface on which the impact is made must be the same mounting surface to which the housing is attached by the engagement means. Murakoshi describes this orientation of the apparatus, where the apparatus is "fixed above… the tabletop." APPLE-1004, [0021].

258. In Figure 1 of Murakoshi, below, I've modified the figure so that the apparatus 104 (orange) is positioned on the vibratory surface 106 (blue) as Murakoshi describes. I use this modified Fig. 1 throughout Ground 1C, which relies on Apple's constructions of the claim terms, including Apple's construction of the claim limitation "said contact interaction being comprised of an impact on said mounting surface" (element [1b-vii]).

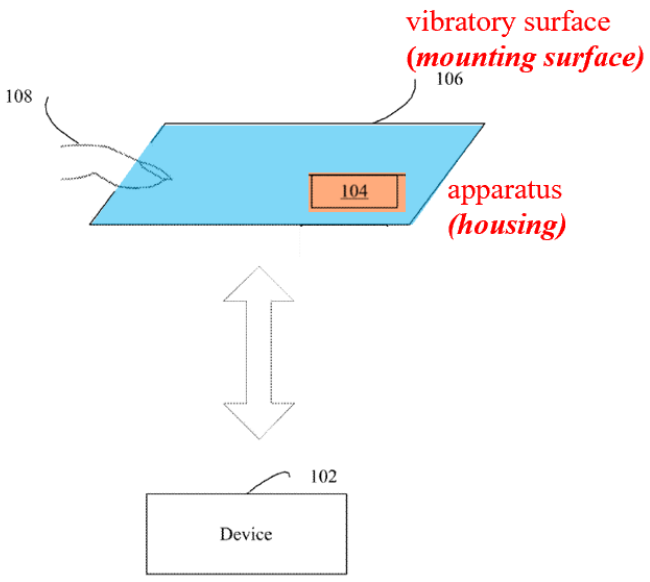


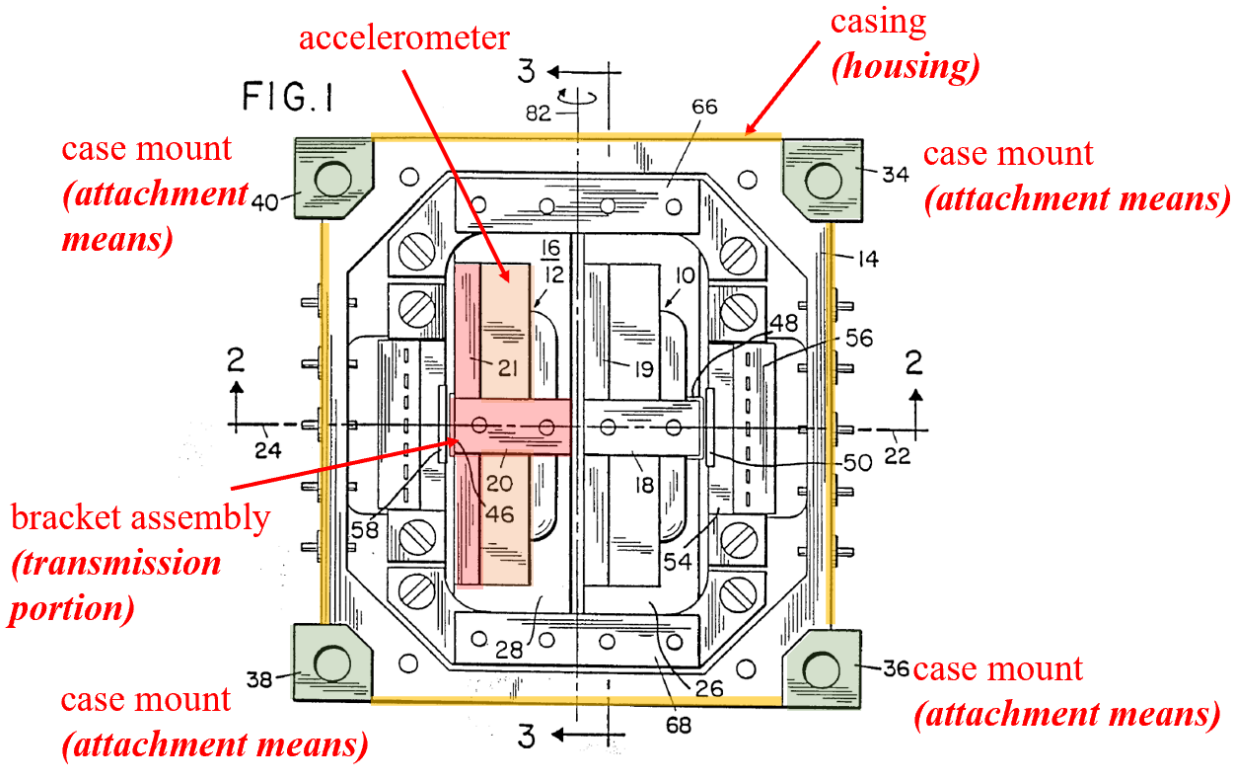
FIG. 1

APPLE-1004, Fig. 1 (annotated) (modified)

engagement means

259. As described above, the term "engagement means" is interpreted under Apple's construction as a means-plus-function term that requires (1) adhesive, mechanical fasteners, threaded screws, or equivalents that attach a housing to a mounting surface and (2) frames and brackets or a spring loaded portion, or equivalents that connect a sensor to the housing. §VIII (Claim Construction). Applying Apple's construction, the Murakoshi-Stewart combination renders obvious an "engagement means" because Stewart teaches (1) case mounts for use with mechanical fasteners and (2) a three-part bracket

assembly. APPLE-1006, 5:8-9, 5:34-37, Fig. 1. A detailed §112(f) analysis for the "engagement means" element is provided below in Element [1e].



APPLE-1006, Fig. 1 (annotated)

[1b-i] a sensor contained within said housing,

260. For the same reasons described above in Ground 1A, Murakoshi discloses this element. §IX.A.4.[1b-i] (Ground 1A). For example, Murakoshi discloses "[t]he apparatus 104 may comprise … one or more sensors, such as a sensor 206" and that "sensor 206 may include… an accelerometer." APPLE-1004, [0025], [0029], [0013].

[1b-ii] said sensor forming an interactive zone defined by a range of said sensor,

261. As described above in Ground 1A, Murakoshi discloses that the sensor detects vibrations of a vibratory surface (mounting surface) within "a pre-defined region" (interactive zone), and that "a user may ***interact at any location within the pre-defined region*** of the vibratory surface 106 to control the user interface of the device 102." APPLE-1004, [0034] (emphasis added), *see also id.*, [0021], [0013], [0016], Fig. 1.

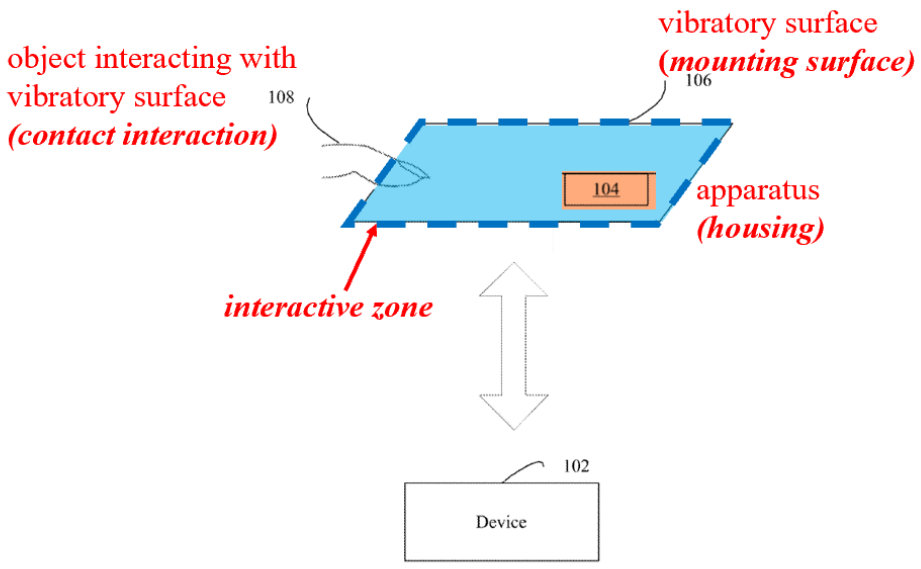


FIG. 1

APPLE-1004, Fig. 1 (annotated) (modified)

262. Under Apple's construction, as described above, the apparatus is fixed to a top of the mounting surface (e.g., the same surface that a contact interaction is made on). §VIII (Claim Construction). Murakoshi's description of the pre-defined

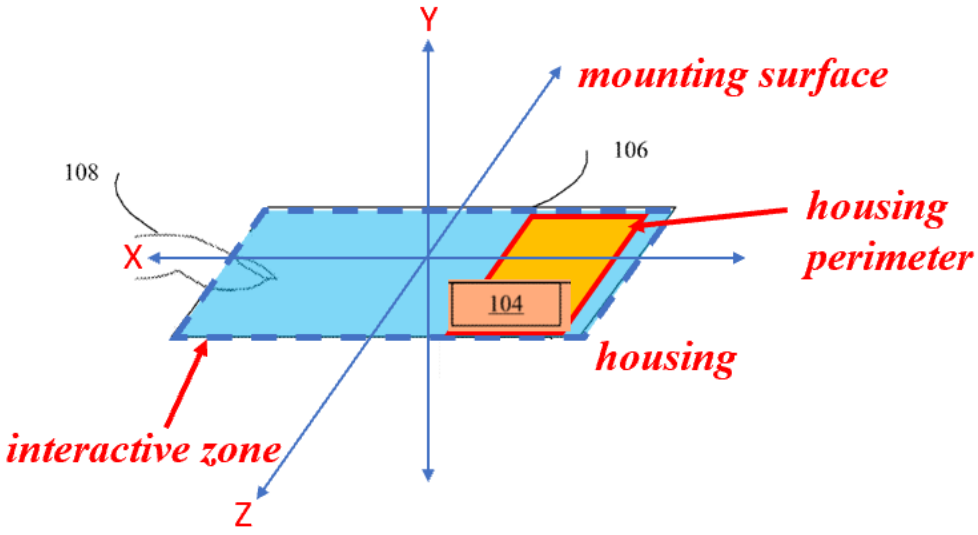
region of the vibratory surface is applicable to this orientation of the housing. As described above, a POSITA would have understood that the pre-defined region of the vibratory surface, per Murakoshi, defines a zone that is within a range of the sensor so that a user's interactions with the surface within the pre-defined zone can be detected by the sensor and used to control device 102. APPLE-1004, [0034].

[1b-iii] said sensor being comprised of an accelerometer,

263. For the same reasons described above in Ground 1A, Murakoshi discloses this element. §IX.A.4.[1b-iii] (Ground 1A). In particular, Murakoshi discloses "[t]he apparatus 104 may comprise … one or more sensors, such as a sensor 206" and that "sensor 206 may include… an accelerometer." APPLE-1004, [0025], [0029], [0013].

[1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing,

264. Because in Murakoshi, a "pre-defined region of a surface may correspond to the vibratory surface 106" (APPLE-1004, [0021]), the pre-defined region formed on the surface is also aligned with the vibratory surface and overlays the vibratory surface. APPLE-1004, [0029], [0016], [0021].



APPLE-1004, Fig. 1 (annotated) (modified)

265. Additionally, Murakoshi's Fig. 1 illustrates that the "pre-defined region" (interactive zone) extends outside the perimeter of the apparatus's housing. APPLE-1004, [0016], Fig. 1. Fig. 1 shows a user interacting with the vibratory surface at a position outside of the housing (e.g., outside a perimeter of a housing). Additionally, Murakoshi describes that "[t]he apparatus 104 may generate a control signal to switch on a lamp placed on the table when a user may scratch on the center of the table," implying that the sensor is capable of detecting vibrations in the interactive zone and outside of the perimeter of the housing. APPLE-1004, [0023].

[1b-v] said sensor being in a fixed position relative to said engagement means,

266. For the same reasons described above in Ground 1A, Murakoshi-Stewart-Sachs-Orr renders this element obvious. §IX.A.4.[1b-v] (Ground 1A). As

described above, an accelerometer (sensor), per Murakoshi, is held in a fixed position within the casing (housing) of the apparatus by a bracket assembly and other structural components that hold the accelerometer (sensor) fixed within the casing (housing) relative to the fasteners that would extend through the case mounts (engagement means) in the Murakoshi-Stewart-Sachs-Orr combination. APPLE-1006, Fig. 1, 5:7-33. Further, as described above, it would have been obvious to a POSITA that it is necessary to hold a sensor in a fixed position relative to a sensing surface to provide a fixed reference point for accurate detection of vibratory signals and processing of those signals in a meaningful way.

[1b-vi] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals,

267. For the same reasons described above in Ground 1A, Murakoshi discloses this element. §IX.A.4.[1b-vi] (Ground 1A). For example, Murakoshi describes that "***the sensor*** 206 ***may detect one or more vibrations*** of the vibratory surface 106 ***caused by an interaction of the object 108 with the vibratory surface.***" APPLE-1004, [0082] (emphasis added). A POSITA would have understood that, as in the '738 patent, in the Murakoshi-Stewart-Sachs-Orr combination the signals sensed by the accelerometer are vibration data signals. APPLE-1001, 5:11-13 ("When the sensor is an accelerometer, the data signals are vibration data, such as amplitude, intensity, and duration.").

[1b-vii] said contact interaction being comprised of an impact on said mounting surface,

268. Under Apple's construction, this claim limitation is construed as "where the contact interaction is a user impact (e.g., a knock) directly on the mounting surface." §VIII (Claim Construction). Murakoshi-Stewart-Sachs-Orr renders this element obvious.

269. Murakoshi describes the interaction of the object with the vibratory surface as "a user may scratch and/or ***tap at any location on the vibratory surface 106*** using the object 108, such as the nail of the finger." *Id.*, [0035], [0022] (emphasis added). Accordingly, Murakoshi discloses that the user can interact with the vibratory surface (mounting) by tapping the surface to impact it. Additionally, as described above, Murakoshi describes that "[t]he apparatus 104 may be fixed above and/or below the table top." *Id.*, [0021]. As illustrated in modified Fig. 1, below, the apparatus is fixed to the mounting surface, and the user interacts directly with the side of the mounting surface to which the apparatus is fixed.

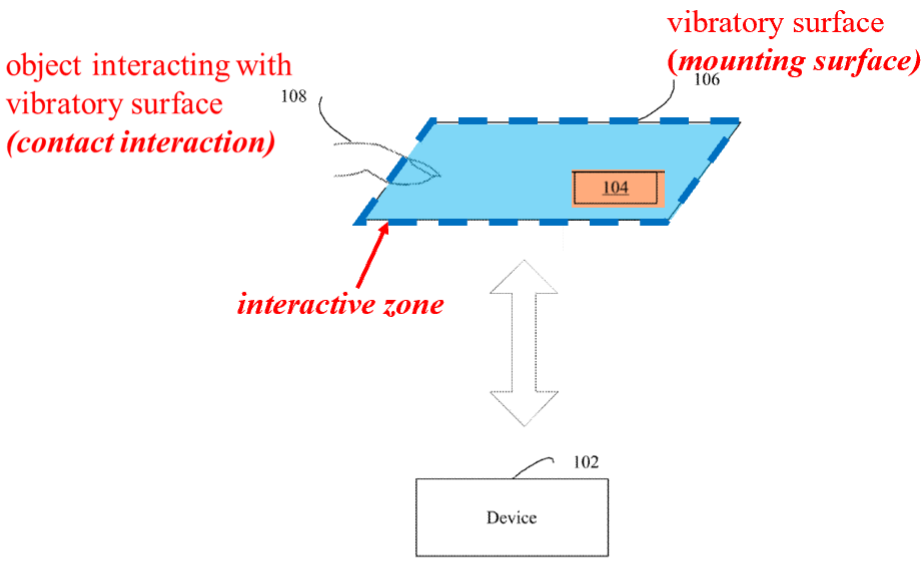


FIG. 1

APPLE-1004, Fig. 1 (annotated) (modified)

[1b-viii] said data signals being comprised of vibration data of said contact interaction;

270. For the same reasons described above in Ground 1A, Murakoshi discloses this element. §IX.A.4.[1b-viii] (Ground 1A). As described above, Murakoshi describes that the accelerometer "may detect one or more ***vibrations*** of the vibratory surface caused by an interaction of an object" with the surface. APPLE-1004, Abstract, [0065]; *see also id.*, [0082], [0084]-[0085]. Murakoshi's description of the detected vibrations from the user interaction with the mounting surface is similar to the way the '738 patent describes the data signals: "[w]hen the sensor is an accelerometer, the data signals are vibration data." APPLE-1001, 5:11-12.

[1c-i] a server in communication with said sensor,

271. Murakoshi-Stewart-Sachs-Orr renders obvious "a server in communication with a sensor." In Murakoshi-Stewart-Sachs-Orr, the processing of the vibratory signals detected by the sensor is carried out at a server, as Orr teaches. §IX.C.2 (Murakoshi-Stewart-Sachs-Orr Combination); APPLE-1004, [0018], [0013], [0016], [0025], Fig. 2; APPLE-1005, [0027] ("a virtual assistant can be implemented according to a client-server model [and] can include a client-side portion executed on a user device 102, and a server-side portion executed on a server system 110"). Orr describes that a virtual assistant can be implemented to communicate with an external server (e.g., a cloud based server). APPLE-1005, [0027], Fig. 1.

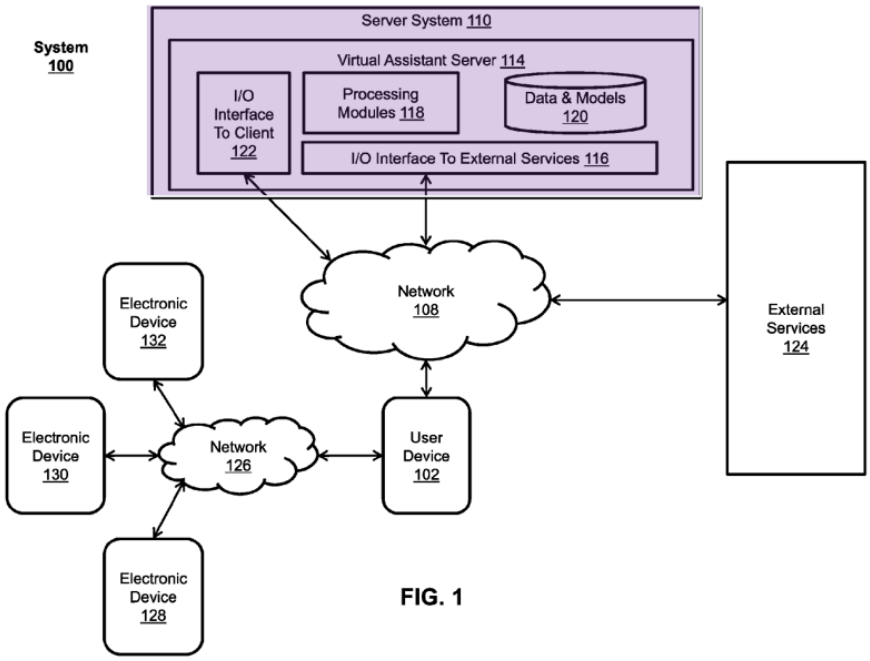


FIG. 1

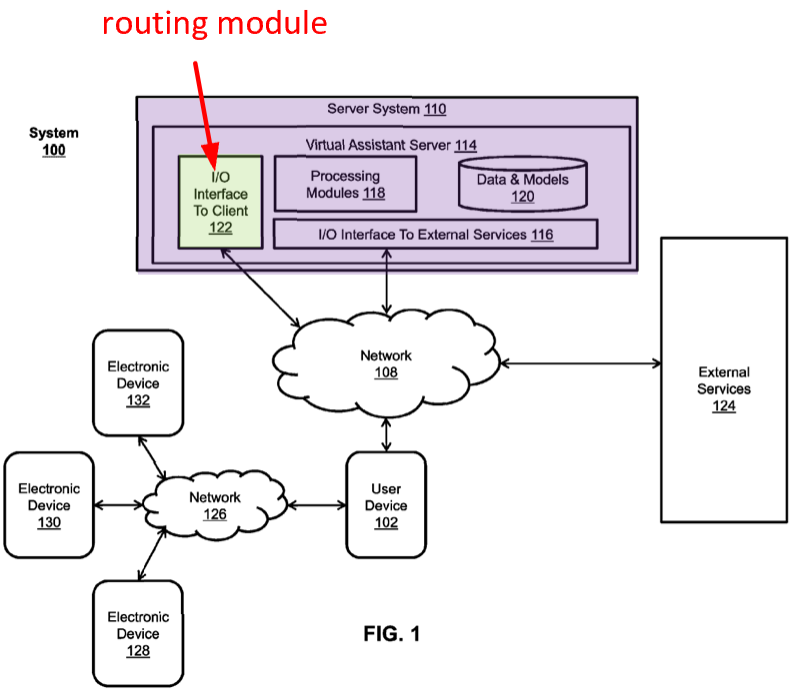
APPLE-1005, Fig. 1 (annotated)

272. Just as the apparatus's processor is able to receive the vibratory signals from the sensor for processing (i.e., is in communication with the sensor), per Murakoshi, Orr describes that a server is also in communication with a user input component. APPLE-1005, [0005] ("a user can speak an input in natural language form to a user device to control one or more electronic devices [and the] user device can transmit the user speech to a server"); APPLE-1004, [0025], Fig. 2. A POSITA would have understood that, in Murakoshi-Stewart-Sachs-Orr, the server is in communication with the sensor to receive the vibratory signals for processing. It would have been obvious to a POSITA to implement a server, per Orr, in the context of the system, per Murakoshi, with the server in communication

with the accelerometer to receive the vibratory signals from the accelerometer to provide more processing power for interpreting tap and scratch-based user inputs. § IX.C.2 (Murakoshi-Stewart-Sachs-Orr Combination).

[1c-ii] said server being comprised of a routing module,

273. Applying Apple's construction, Murakoshi-Stewart-Sachs-Orr renders obvious a "routing module" because Orr discloses an I/O interface that routes and receives data signals from the sensor. §VIII (Claim Construction); APPLE-1004, [0032], [0018], [0025]; APPLE-1005, [0028] ("the client-facing I/O interface 122 can facilitate the client-facing input and output processing for virtual assistant server 114"), [0051]-[0052]. A POSITA would have understood that "I/O interface" stands for "Input-Output interface," and that Orr's I/O interface enables the input of signals into the server and the output of signals from the server. APPLE-1005, [0028]. A detailed §112(f) analysis for the "routing module" element is provided below in Element [1c-v].

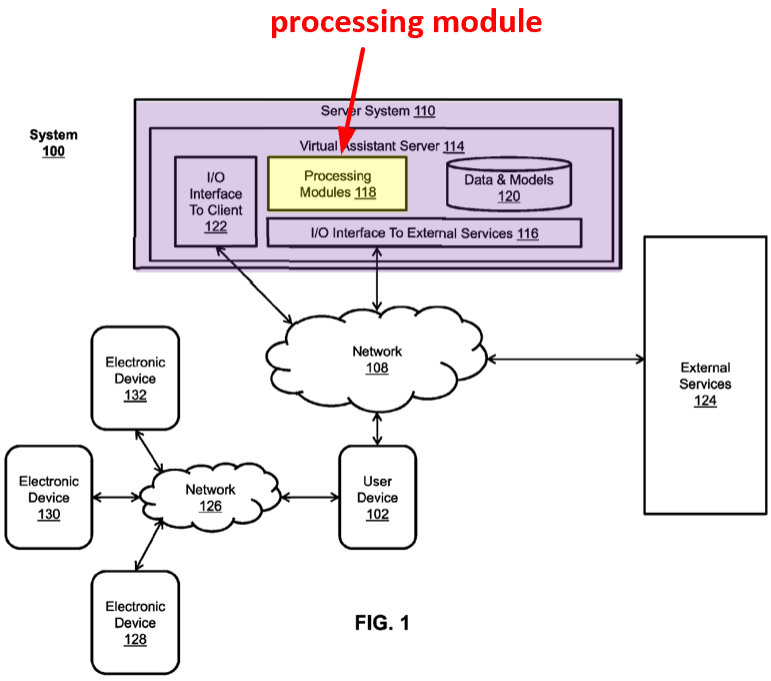


APPLE-1005, Fig. 1 (annotated)

[1c-iii] a processing module being connected to said routing module, and

274. Applying Apple's construction, Murakoshi-Stewart-Sachs-Orr renders obvious a "processing module" because Orr discloses a processing module connected to the I/O interface (routing module). §VIII (Claim Construction); APPLE-1004, [0013], [0023], [0025], [0027], [0036], [0048]; APPLE-1005, [0028], [0056], [0081], [0091]-[0092], Figs. 7-9. Orr explains that, in the context of Orr's virtual assistant, the processing module "can utilize data and model storage 120 to determine the user's intent based on natural language input, and perform task execution based on inferred user intent." APPLE-1005, [0028]. More generally, the processing module described by Orr uses models or algorithms

to process the signals from the user input to determine a corresponding user command. *Id.* A detailed §112(f) analysis for the "processing module" element is provided below in Element [1c-vi].

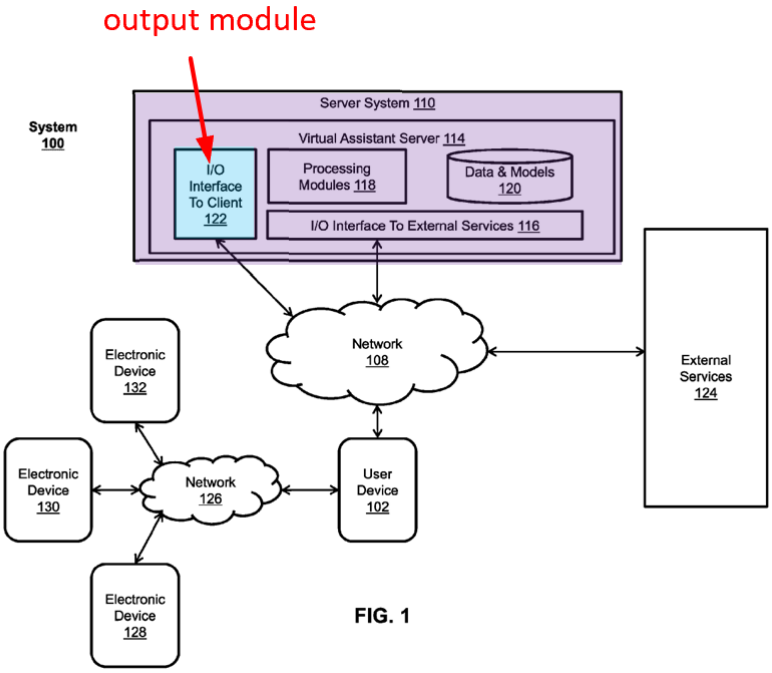


APPLE-1005, Fig. 1 (annotated)

[1c-iv] an output module connected to said processing module,

275. Applying Apple's construction, Murakoshi-Stewart-Sachs-Orr renders obvious an "output module" because Orr discloses an I/O interface, which a POSITA would have understood from Murakoshi's disclosure acts as a transmitter and is connected to the processor. §VIII (Claim Construction); APPLE-1004, [0026], [0048]; APPLE-1005, [0028] ("I/O interface 122 can facilitate the client-facing input and output processing for virtual assistant server 114"), [0049],

[0062], [0056], [0081], [0091]-[0092], Figs. 7-9. As described above, a POSITA would have understood that that Orr's I/O interface enables the input of signals into the server and the output of signals from the server. APPLE-1005, [0028]. A detailed §112(f) analysis for the "output module" element is provided below in Element [1d-v].



APPLE-1005, Fig. 1 (annotated)

[1c-v] said routing module receiving said data signals from said sensor,

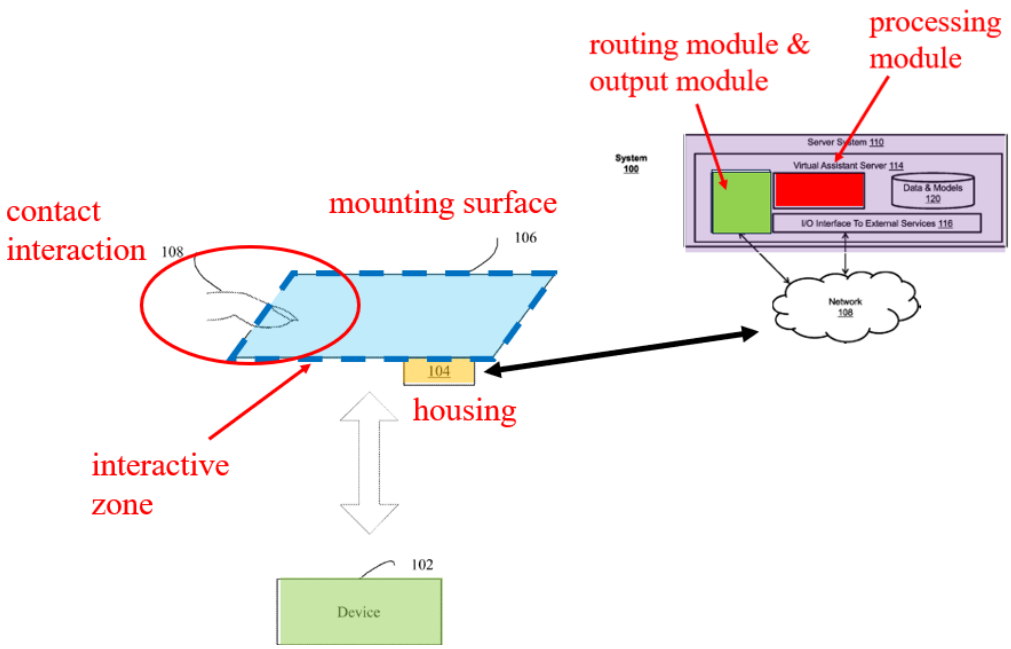
276. Applying Apple's construction, "routing module" is treated under §112(f) as a means-plus-function term which functions to route and receive data signals from the sensor. §VIII (Claim Construction). Under Apple's construction, the corresponding structure is "routing module 44" and equivalents thereof. *Id.*;

APPLE-1001, 5:25-31, 9:40-45, 10:59-67, 11:20-24, FIG. 1. Murakoshi-Stewart-Sachs-Orr meets this construction of routing module.

277. As described above, Orr discloses an I/O interface that a POSITA would have understood functions as a receiver to receive data signals from the sensor and route the signals to the processing module. §IX.C.3.[1c-ii] (Ground 1C); APPLE-1005, [0028] ("I/O interface 122 can facilitate the client-facing input and output processing for virtual assistant server 114"), [0051]-[0052]; APPLE-1004, [0032] ("the receiver 210 may receive the vibratory signal generated by the sensor 206"), [0062]. A POSITA would have understood that Orr's I/O interface acting as a receiver is an equivalent of the claimed routing module, because it receives signals from a user input before transmitting the signals to the processing module for processing.

278. Orr describes that a server includes "a client-facing I/O interface 122 [which can] facilitate the client-facing input and output processing for virtual assistant server 114." APPLE-1005, [0028], [0051]-[0052]. Orr further describes that "data corresponding to the audio input transmitted by the user device … can be received by one or more servers." APPLE-1005, [0052]. Based on Orr's disclosure, a POSITA would have understood that the data is received at the server through the I/O interface 122.

279. A POSITA would have also understood this function of the I/O interface as a receiver based on Murakoshi's disclosure that the apparatus includes a receiver which "may comprise suitable logic, circuitry, interfaces, and/or code that may be operable to receive data and messages" and "the receiver 210 may receive the vibratory signal generated by the sensor 206 external to the apparatus 104 [and] may implement known technologies for supporting wired or wireless communication between the apparatus 104 and the sensor 206." APPLE-1004, [0032], [0018], [0025]. A POSITA would have understood that the I/O interface, per Orr, functions as a receiver in Murakoshi-Stewart-Sachs-Orr based on the disclosures of Murakoshi and Orr. A POSITA would have further understood that in the Murakoshi-Stewart-Sachs-Orr combination, the I/O interface of the server, functioning as a receiver, receives the vibration data received from the accelerometer.



APPLE-1004, Fig. 1 (annotated and modified with APPLE-1005, Fig. 1)

280. In Murakoshi-Stewart-Sachs-Orr, the I/O interface not only receives the vibratory signals from the accelerometer, but also transfers the signals to the processing module to be processed. A POSITA would have understood that the signals received at the I/O interface receiver from the accelerometer must be routed within the server to the processing module for processing because both Murakoshi and Orr describe that after the signals are received, the signals are processed. The signals enter the server at the I/O interface, and a POSITA would have understood that the signals are routed from the I/O interface to the processor in order to be processed. Accordingly, Murakoshi-Stewart-Sachs-Orr renders obvious a "routing module" by providing a receiving portion of an I/O interface (an equivalent of a routing module) which performs the claimed function.

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and

281. Applying Apple's construction, "processing module" is treated under §112(f) as a means-plus-function term which functions to process data, determine a data pattern corresponding to the data signals, and match the data pattern with a gesture profile. §VIII (Claim Construction). Under Apple's construction, the corresponding structure is "processing module 46" and equivalents thereof. APPLE-1001, 5:25-38, 8:66-9:14, 9:40-50, 10:33-36, 10:59-11:2, FIGS. 1-2; §VIII (Claim Construction). Murakoshi-Stewart-Sachs-Orr meets this construction of routing module.

282. Murakoshi-Stewart-Sachs-Orr renders this limitation obvious, at least because Orr discloses a processing module which a POSITA would have understood in the Murakoshi-Stewart-Sachs-Orr combination includes logic and circuitry that performs several processing steps described by Murakoshi to determine a data pattern (i.e., identifying "vibratory signal components," APPLE-1004, [0038]) corresponding to the data signals and matches the data pattern with a gesture profile (i.e., identifying and generating a "control signal corresponding the one or more generated vibratory signals," APPLE-1004, [0038]). APPLE-1005, [0028], [0056]; §IX.C.3.[1c-iii] (Ground 1C). Additionally, as described above, in the Murskoshi-Stewart-Sachs-Orr combination, the processing incorporates Sachs'

teaching to identify data features in the vibration data to efficiently process the data and recognize a user gesture. *Supra* §IX.B.2 (Murakoshi-Stewart-Sachs Combination); APPLE-1007, Abstract, [0009], [0014]-[0015].

283. For example, Murakoshi describes that, after detection of the vibrations (data signals), the apparatus may "generate one or more vibratory signals in response to the detected one or more vibrations" and the processor (processing module) is then able to "generate a control signal corresponding to the one or more generated vibratory signals to control the user interface of the device." APPLE-1004, [0013]. The processing module "convert[s] each of the generated one or more vibratory signals into vibratory signal components." APPLE-1004, [0038]. A POSITA would have understood that, in the combination, vibratory signal components, per Murakoshi, make up a data pattern determined by the processing module, as Orr teaches. APPLE-1004, [0015], [0028], [0038], [0042]-[0044]; APPLE-1005, [0028], Fig. 1. This is because the "vibratory signal components" that Murakoshi describes, such as vibrational frequency associated with the signal, are characteristics of the signal that can be used to match the detected signal to a stored signal – these characteristics are the "data pattern" that describes the unique vibration data associated with a user gesture. APPLE-1004, [0015] ("The determined vibration frequency is indicative of an operation associated with the device"), [0028] (describing "frequency-operation mapping

data"), [0047], [0048] ("The frequency-operation mapping data may specify an operation of the device 102 to be controlled in response to a vibration frequency of a vibratory signal"), [0049] ("the manufacturer and/or the user may define the vibration frequency that corresponds to scratching on the vibratory surface 106 that may indicate volume control operation of a television"). Murakoshi's description of processing the vibratory signal to identify signal components such as vibration frequency that are mapped to user control operations is consistent with the disclosure of the '738 patent which describes that a data pattern is defined by components of the data including peaks and timings. APPLE-1001, 5:5-8. A data pattern is a set of features identified in the data that can be used to match the data to a stored profile, and Murakoshi discloses just such a data pattern in its disclosure of determining vibration frequencies of the data signal. APPLE-1004, [0015], [0028], [0042]-[0044].

284. Additionally, in the Murakoshi-Stewart-Sachs-Orr combination, a processing module uses the vibratory signal components (data patterns), including the signal data features taught by Sachs, to identify a corresponding control signal. APPLE-1004, [0015] ("The determined vibration frequency is indicative of an operation associated with the device"), [0048]; APPLE-1007, [0009]-[0010], [0015] ("The use of data features in motion sensor data allows gestures to be recognized with reduced processing compared to processing all the motion sensor

data"), [0123] (identifying a data feature of "a maximum (or minimum) height (or magnitude) [] of the waveform"), [0101] (identifying a data feature of "a detected tap pulse 282 shown as a large magnitude pulse"), [0126] (identifying as a data feature " time values appropriate to the data feature detected"), [0094] (identifying as a data feature "a predetermined period of time…during which no additional large-magnitude pulses are detected"); *supra* §§(Ground 1B Combination). Murakoshi describes that "the processor 202 may determine a control signal that corresponds to the determined vibration frequency based on frequency-operation mapping data stored in the memory 204." APPLE-1004, [0048], [0023], [0025], [0027], [0036], [0048]. A POSITA would have understood from Murakoshi's disclosure that the processor determines vibratory signal components including vibration frequency (data pattern) and matches the data pattern to frequency-operation mapping data to identify the corresponding control signal —a gesture profile associated with a command. APPLE-1004, [0015] ("The determined vibration frequency is indicative of an operation associated with the device"), [0028] (describing "frequency-operation mapping data"), [0047], [0048] ("The frequency-operation mapping data may specify an operation of the device 102 to be controlled in response to a vibration frequency of a vibratory signal"), [0049] ("the manufacturer and/or the user may define the vibration frequency that

corresponds to scratching on the vibratory surface 106 that may indicate volume control operation of a television").

285. A POSITA would have understood that in Murakoshi-Stewart-Sachs-Orr, the processing module at the server, per Orr, would have functioned to determine a data pattern from the vibratory signal components associated with the user taps and scratches—as taught by Murakoshi and Sachs—and would have matched the data pattern with mapped data—again as Murakoshi teaches—to identify the corresponding control signal; that is, a gesture profile associated with a command. Accordingly, Murakoshi-Stewart-Sachs-Orr renders obvious a "processing module" by disclosing a processing module of a server which performs the claimed function.

[1d-i] a terminal device

286. Applying Apple's construction, Murakoshi-Stewart-Sachs-Orr renders obvious a "terminal device." §VIII (Claim Construction). As described above, Apple's construction requires that a terminal device be "a remote device" consistent with the treatment of the term in the '738 patent. APPLE-1001, Abstract, 1:40-48, 1:54-66, 2:3-8, 2:21-24, 2:38-40, 3:26-29, 3:61-63, 4:31-36, 5:39-55, 6:3-6, 6:33-48, 6:60-61, 9:65-67, 11:43-49, Claim 8, FIG. 1. Murakoshi teaches a device (such as a laptop, computer, television, lamp or other home appliance) that performs an action associated with a received control signal.

APPLE-1004, [0017], [0064] (describing a lamp), [0084] (same). Murakoshi's device 102 is a terminal device that is remote from the apparatus that senses the vibrations, and accordingly, Murakoshi-Stewart-Sachs-Orr renders obvious a "terminal device."

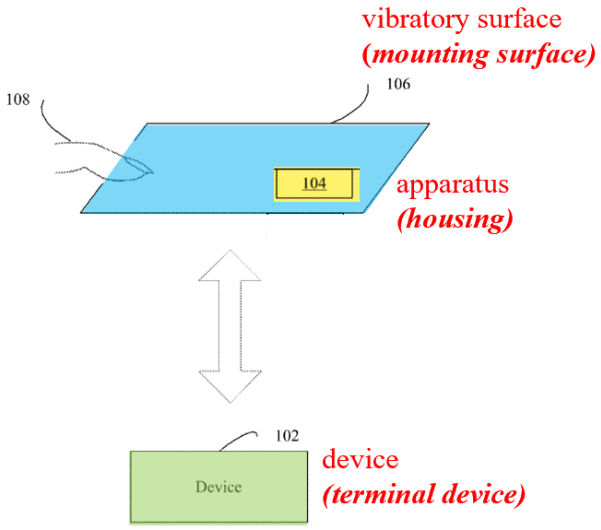


FIG. 1

APPLE-1004, Fig. 1 (annotated) (modified)

[1d-ii] being comprised of a receiving module

287. Under Apple's construction, Murakoshi-Stewart-Sachs-Orr renders obvious a "receiving module" of the terminal device because Murakoshi discloses that the device 102 (terminal device) includes "***one or more processors and/or circuits… operable to receive a control signal from the apparatus 104***." APPLE-1004, [0093] (emphasis added); §VIII (Claim Construction). Murakoshi's device 102 (terminal device) is described as including one or more components that allow

the device to receive signals from the apparatus, and thus Murakoshi-Stewart-Sachs-Orr renders obvious [1d-ii]. A detailed §112(f) analysis for the "receiving module" element is provided below in Element [1d-v].

[1d-iii] and means for initiating activity of said terminal device corresponding to said command,

288. Applying Apple's construction, "means for initiating activity of said terminal device corresponding to said command" is treated under §112(f) as a means-plus-function term which functions to initiate activity of said terminal device corresponding to said command. §VIII (Claim Construction). Under Apple's construction, the corresponding structure is a "switch or other actuating mechanism that changes the status of a terminal device" and equivalents thereof. APPLE-1001, 5:53-55; §VIII (Claim Construction). Murakoshi-Stewart-Sachs-Orr meets this construction of means for initiating activity of the terminal device.

289. For example, Murakoshi discloses that "[t]he apparatus 104 may generate a control signal ***to switch on*** a lamp placed on the table when a user may scratch on the center of the table." APPLE-1004, [0023] (emphasis added), [0050] ("The control signal may switch on and/or switch off the home appliance."), [0093]. Murakoshi's disclosures of a device switching on or off indicate a change in status of the device (e.g., from on to off and vice versa). Accordingly, Murakoshi discloses that a status (e.g., on or off) of the terminal device (e.g., a lamp) is changed by the control signal. Based on Murakoshi's disclosure of the

change in status of the terminal device in response to the control signal, a POSITA would have understood that in the combination, the device (terminal device) includes a switch (means for initiating activity) that initiates the activity associated with the control signal received by the device. APPLE-1004, [0023], [0050]. Murakoshi describes that the control signal instructs a device to change a state/status and the device makes the instructed change in state—a POSITA would have understood it to be axiomatic that the device has a mechanism that allows it to implement the change in status (e.g., a "means for initiating activity"). A POSITA would have further understood that a terminal device that includes a mechanism for executing a status change in response to a control signal would include circuitry, a switch, or other actuating mechanism that operates the terminal device and switches between statuses. If the device did not include such a component, it would not be able to initiate the change in status Accordingly, Murakoshi-Stewart-Sachs-Orr renders obvious a "means for initiating activity" by disclosing switches or other mechanisms preforming the claimed function.

[1d-iv] said terminal device being in communication with said server,

290. A POSITA would have understood that in Murakoshi-Stewart-Sachs-Orr, the terminal device is in communication with the server in order to receive control signals as Murakoshi and Orr describe. APPLE-1004, [0016], [0018], [0023], [0048], [0093]. In Murakoshi-Stewart-Sachs-Orr, the processing of the

vibratory signal to generate a control signal is conducted at a server, as Orr teaches, and the terminal device is in communication with the server in order to receive the control signal. §IX.C.2 (Murakoshi-Stewart-Sachs-Orr Combination). A POSITA would have understood that implementing the Murakoshi-Stewart-Sachs-Orr in this way would have optimized the efficiency of controlling the terminal device, because the generated control signal would be transmitted directly to the terminal device after being generated at the server. This is illustrated by the arrow between the server (purple) and the terminal device (green) in the modified figure below.

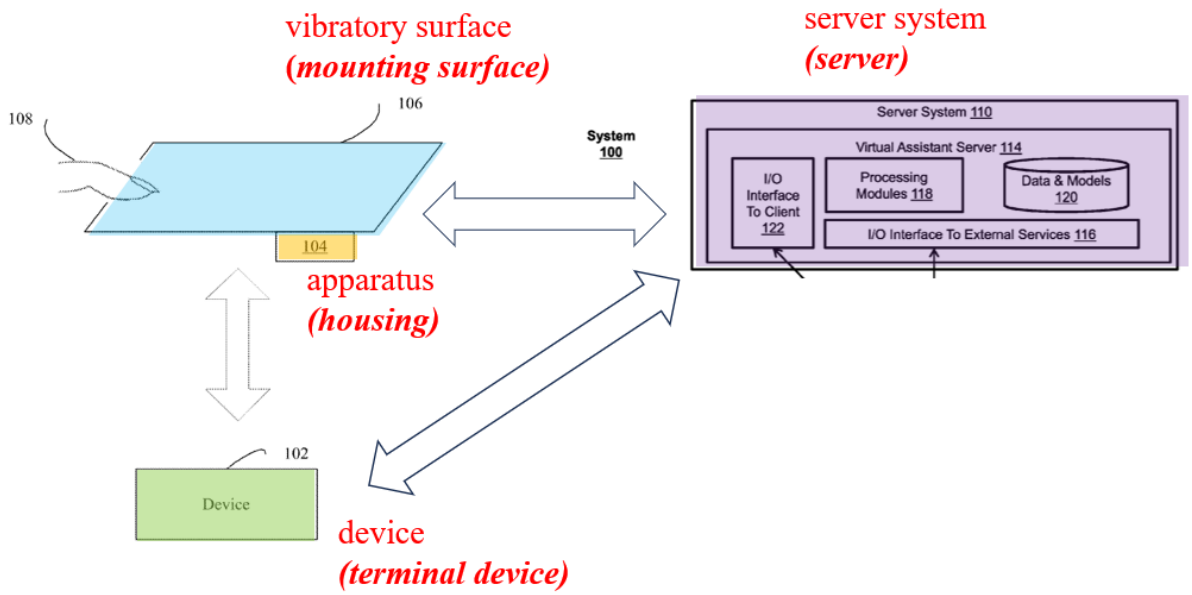


FIG. 1

APPLE-1004, Fig. 1 (modified to include server of APPLE-1005, Fig. 1)

Even if the server were to be implemented to transmit the generated control signal to the apparatus (see arrow between server and apparatus in figure above) such that

the apparatus would then transmit the control signal to the terminal device (see arrow between apparatus and device in figure above), a POSITA would have recognized that the terminal device is in communication with the server via the apparatus. Regardless of the implementation, a POSITA would have understood that in the Murakoshi-Stewart-Sachs-Orr combination, the terminal device is communicatively coupled to the server.

[1d-v] said output module transmitting said command to said receiving module,

291. This claim limitation includes two claim terms that are subject to §112(f) under Apple's construction. I deal with each in turn below.

Output module

292. Applying Apple's construction, "output module" is treated under §112(f) as a means-plus-function term which functions to output and transmit a command to said receiving module of the terminal device. § III (Claim Construction). Under Apple's construction, the corresponding structure is "output module 48" and equivalents thereof. APPLE-1001, 9:42-61, 10:59-64, 11:7-9, Fig. 1; §VIII (Claim Construction). Murakoshi-Stewart-Sachs-Orr meets this construction of output module.

293. Murakoshi-Stewart-Sachs-Orr renders this limitation obvious, at least because Orr discloses an I/O interface which a POSITA would have understood from Murakoshi's disclosure acts is connected to the processor and acts to output

and transmit a command to the terminal device. APPLE-1004, [0026], [0048]; APPLE-1005, [0028], [0049], [0062]; §IX.C.3.[1c-iv] (Ground 1C). For example, Murakoshi describes that"[t]he processor 202 may communicate the generated control signal to the device 102 via the transmitter 212." APPLE-1004, [0026], [0048], [0033]. A POSITA would have understood that from Murakoshi's teaching that a command must be transmitted from the apparatus to the terminal device by an output module – for example a transmitter per Murakoshi or an I/O interface per Orr. A POSITA would have understood that Murakoshi-Stewart-Sachs-Orr's I/O interface, acting as a transmitter as Murakoshi teaches, would output and transmit the command to the terminal device.

Receiving module

294. Additionally, applying Apple's construction, "receiving module" is treated under §112(f) as a means-plus-function term which functions to receive the command from the output module of the server. §VIII (Claim Construction). Under Apple's construction, the corresponding structure is "receiving module 52" and equivalents thereof. APPLE-1001, 10:63-64 and 11:6-9; §VIII (Claim Construction). Murakoshi-Stewart-Sachs-Orr meets this construction of receiving module. For example, Murakoshi discloses that device 102 (terminal device) includes "***one or more processors and/or circuits… operable to receive a control signal from the apparatus 104***." APPLE-1004, [0093] (emphasis added). A

POSITA would have understood that Murakoshi's "processors and/or circuits" which "receive a control signal" are equivalents of the claimed receiving module and accomplish the same function – receiving the command from the output module (i.e., I/O interface transmitter).

295. Accordingly, a POSITA would have understood that the I/O interface, per Orr, functions as a transmitter ("output module") to output and transmit the control signal from the server to the terminal device. APPLE-1005, [0028], [0062], [0049], Fig. 1; APPLE-1004, [0023], [0050], [0093]. As described above, a POSITA would have understood that an I/O interface, as taught by Orr, enables the input of signals into the server and the output of signals from the server. APPLE-1005, [0028]. In the Murakoshi-Stewart-Sachs-Orr combination, the I/O interface operates to perform the functions of a transmitter, per Murakoshi – that is, transmitting a control signal to control a device based on the user's input gesture. A POSITA would have further understood that the terminal device's "processors and/or circuits" (receiving module) receives the control signal from the I/O transmitter of the server. APPLE-1004, [0093] ("one or more processors and/or circuits… operable to receive a control signal from the apparatus 104"), [0023], [0050], [0033]. Accordingly, Murakoshi-Stewart-Sachs-Orr renders obvious an "output module transmitting said command to said receiving module."

[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion.

296. Under Apple's proposed construction, the "engagement means" claim limitation is treated under §112(f) as a means plus function term which has the functions of engagement, attaching or holding the housing to the mounting surface, transmitting data signals from the attachment means to the senor, and connecting the sensor to said attachment means of said housing to set a rigid position of said sensor relative to the mounting surface. §VIII (Claim Construction); APPLE-1001, 4:46-51, 4:65-66, 6:67-7:17, 7:27-29, 8:9-52, FIGS. 3-9. Under Apple's construction, the corresponding structure is "adhesive, mechanical fasteners, [or] threaded screws" (APPLE-1001, 7:1-7) and transmission portion 28 which includes "frames and brackets 38 or a spring loaded portion" (APPLE-1001, 7:7-9) each of which are comprised of a material with flexibility different from the mounting surface and configured to reduce damping, and equivalents thereof. *See also id*. at 4:46-49, 6:67-7:9, 8:9-47.

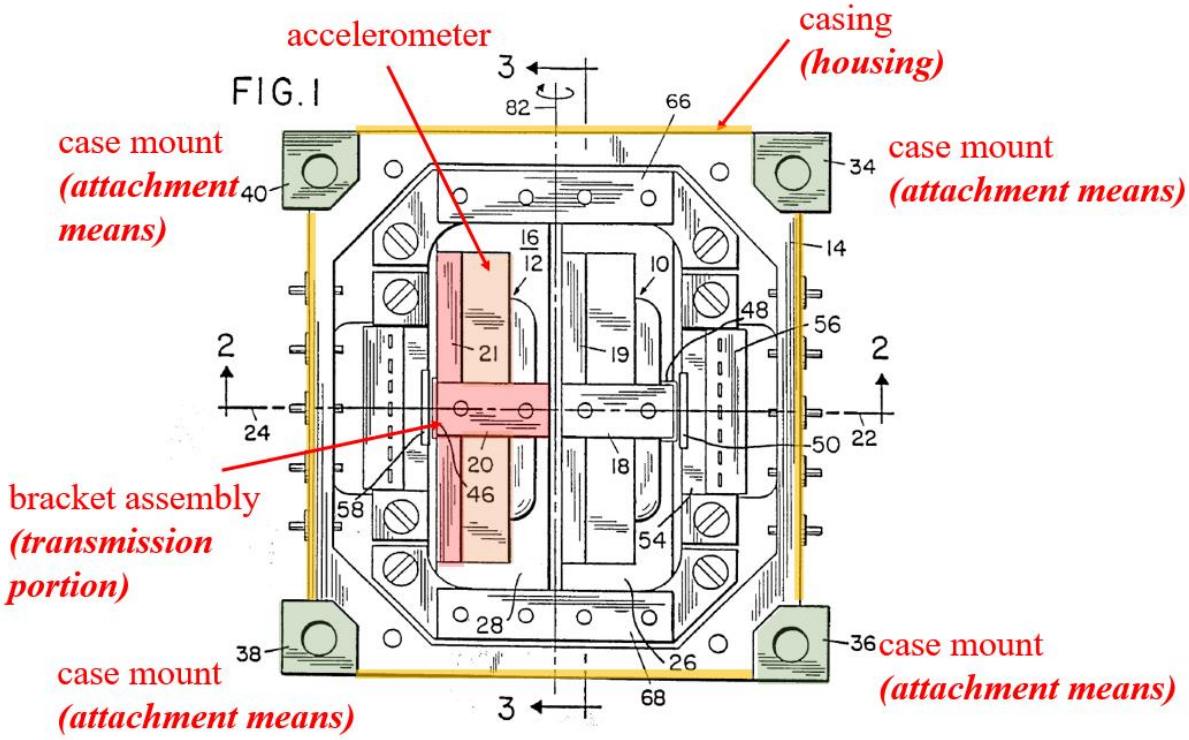
297. In particular, Stewart teaches case mounts for use with mechanical fasteners that attach the housing to the mounting surface (i.e., "attachment means"). APPLE-1006, 5:8-9 ("accelerometers are positioned within a cavity 16

within the case 14."), 5:34-37 (referring to "case mounts"), Fig. 1. In Murakoshi-Stewart-Sachs-Orr, the apparatus, including the casing (housing) taught by Stewart, includes case mounts used with mechanical fasteners to attach the housing to the mounting surface. APPLE-1006, 5:34-37, Fig. 1; §IX.C.2 (Murakoshi-Stewart-Sachs-Orr Combination).

298. It would have been obvious to a POSITA that the case mounts described and illustrated in Stewart would have been used with a mechanical fastener such as a bolt or a screw to attach the casing/housing to a mounting surface (*i.e.*, to mount the case), as Murakoshi directs. APPLE-1004, [0021]. For example, Murakoshi instructs that "[t]he apparatus 104 may be coupled to the vibratory surface 106 [and further] may be fixed on the vibratory surface." *Id*. A POSITA would have understood Murakoshi's instruction to "couple" or "fix" the apparatus to the surface as an instruction to use a fixation device or a fastener to attach the apparatus to the surface, permanently or semi-permanently. A POSITA would have further understood that Stewart's case mounts are formed as tabs with holes therethrough that would have been understood to be used with a fastener to attach the case/housing to a surface. The teachings of both Murakoshi and Stewart would have motivated the POSITA to use Stewart's case mounts with fasteners to couple and fix the casing/housing to the surface. As described above, a POSITA would have appreciated that fixing the housing of the sensor with respect to the

surface to be sensed would allow the sensor to operate as intended and to sense vibrations of the surface without attenuation due to mis-alignment of the sensor with regard to the surface or due to mechanical play between the housing of the sensor and the surface.

299. Accordingly, the Murakoshi-Stewart-Sachs-Orr combination renders obvious an "attachment means" at least because Stewart discloses that the casing includes case mounts for use with mechanical fasteners to attach the housing to the mounting surface.



APPLE-1006, Fig. 1 (annotated)

300. Stewart also teaches a three-part bracket assembly that connects the sensor to the attachment means of the housing, sets a rigid position of the sensor

relative to the mounting surface, and transmits data signals from the attachment means to the sensor (i.e., "transmission portion"). APPLE-1006, 5:8-33, 5:54-61; APPLE-1004, [0013], [0020], [0023], [0029]-[0030], [0036]; §VIII (Claim Construction). For example, Stewart describes that "[a]ccelerometer 10 is attached to ***a three-part bracket assembly*** that includes the finger 18 and the beam 19." APPLE-1006, 5:9-11. Further, Stewart describes that the accelerometer is held between sidewalls by spaced fingers and sidebeams that extend the length of the cavity, which allows the accelerometer to vibrate within the casing. APPLE-1006, 5:54-61. A POSITA would have appreciated that Stewart's teaching to hold the sensor within the housing (and relative to the casemounts of the housing and fasteners passing through) using brackets is a teaching to connect the sensor to the housing and attachment means. Accordingly, Murakoshi-Stewart-Sachs-Orr renders obvious a "transmission portion" at least because Stewart teaches a three-part bracket assembly that connects the sensor to the case mounts and fasteners (attachment means) of the casing (housing).

301. As illustrated in Figure 1 above, the accelerometer is held within the casing by the bracket assembly – the bracket assembly couples the accelerometer to the sidewalls of the casing. Further, the casing includes the case mounts that a POSITA would have understood would have been used with mechanical fasteners to couple the housing to the mounting surface. Collectively, the three-part bracket

assembly and case mounts with mechanical fasteners couple a sensor to the housing and the housing to a mounting surface. Accordingly, under Apple's construction, the corresponding structures to the functions of the "engagement means" are met by the case mounts and fasteners that attach the housing to the vibratory surface and the bracket assembly connecting the sensor to the housing and case mounts/fasteners. Additionally, as I will explain next, these structures perform the functions of the claimed "engagement means" under Apple's construction.

Connecting said sensor to said attachment means of said housing to set a rigid position of the sensor relative to the mounting surface

302. Murakoshi-Stewart-Sachs-Orr provides that the brackets taught by Stewart are a material with a flexibility different than said mounting surface, as claimed so as to set a rigid position of the sensor relative to the mounting surface. Stewart teaches an accelerometer is held in a position using a three-part bracket assembly that attaches the accelerometer (sensor) within the casing (housing) and relative to the vibratory surface so that the accelerometer is protected and held in a position such that it can sense vibrations efficiently and without interference. APPLE-1006, 5:8-20, 5:54-61. A POSITA would have understood that an accelerometer would sense vibrations more effectively if it was secured within its housing rather than free to move about or attached with some play between the

accelerometer and the structures of the housing or between the housing and the mounting surface. Accordingly, a POSITA would have understood from Stewart's teachings that the accelerometer is held rigidly within the housing by the bracket assembly (while components of the accelerometer are still able to move as required for sensing the vibrations, of course).

Transmission portion …being comprised of a material with flexibility different than said mounting surface

303. Additionally, a POSITA would have understood that the bracket assembly's composition and structure would have different specifications (e.g., material, thickness, flexibility) than Murakoshi's vibratory surface (e.g., a tabletop). APPLE-1004, [0020], [0030], [0023]. For example, Murakoshi discloses that the vibratory surface, for example, a tabletop, can be composed of a variety of materials including "wood, glass, plastic, metal, cardboard, concrete, and the like." APPLE-1004, [0020]. A POSITA would have understood that the composition and structure of the three-part bracket assembly would be a different material than Murakoshi's vibratory surface (e.g., a tabletop) because of differences in material and/or thickness of the feature. *Id.*, [0020] ("The vibratory surface 106 may correspond to any surface capable of generating vibrations… Examples of such vibratory surface 106 may include, but are not limited to, a table

top, a wall, a cover of the device, and/or any surface capable of generating vibrations"), [0030], [0023].

Transmitting data signals from the attachment means to the sensor

304. A POSITA would have recognized that the bracket assembly holds the accelerometer within the casing while still transmitting vibrations from the vibratory surface from the casing to the accelerometer. Further, as described above, a POSITA would have understood that the brackets, support flexures, and casing described by Stewart hold the sensor rigidly in place relative to the attachment means, and thus also hold the sensor in a rigid position relative to Murakoshi's vibratory surface. *Supra* §IX.C.3.[1b-v] (Ground 1C) ("said sensor being in a fixed position relative to said engagement means"); APPLE-1006, 5:8-33, 5:54-6. As described above, a POSITA would have understood that the sensor must be held in a fixed position relative to the measured surface, in order to have a fixed reference point for detection of vibratory signals and processing of those signals in a meaningful way.

305. Finally, regardless of the exact bounds of the limitation "said contact interaction generating said data signals of said sensor through said transmission portion," Murakoshi-Stewart-Sachs-Orr includes at least the '738 patent's preferred embodiment. The '738 patent states that "[t]he contact interaction 60 is detected as data signals 70 by the sensor 30…." APPLE-1001, 10:57-59, Fig. 2.

Like the ’738 patent, Murakoshi-Stewart-Sachs-Orr’s contact interaction (e.g., a tap/scratch on the vibratory surface) is detected as data signals (vibratory signals) by the sensor (accelerometer). APPLE-1004, [0020], [0023], [0029]-[0030], [0036]; APPLE-1006, 5:8-20, 5:54-6:1; *see* Element [1a] and [1b-vi].

306. Murakoshi discloses that “in response to the interaction of the object 108 with the vibratory surface 106, the ***sensor 206 may sense vibrations generated in the vibratory surface 106***.” APPLE-1004, [0036], [0013] (emphasis added). Murakoshi’s “sensor 206 may be operable to generate one or more ***vibratory signals in response to the detected one or more vibrations***.” *Id.*, [0029], [0036] (emphasis added). Stewart discloses that and accelerometer includes an inertial mass member “positioned and suspended to react to and to provide a signal that is a measure of acceleration of the supporting structure along a predetermined axis.” APPLE-1006, 6:20-32. From Murakoshi’s and Stewart’s disclosure, a POSITA would have understood that the vibrations (data signals) associated with a user’s tapping on the vibratory surface (contact interaction) is transmitted to the accelerometer (sensor) through the three-part bracket assembly (transmission portion).

b) Claim 10

[10pre]-[10c], [10e-ii]-[10g], [10k-ii]-[10l]

307. Murakoshi-Stewart-Sachs-Orr renders obvious elements [10pre]-[10k-i] for the same reasons described above with regard to Claim 1. *Supra* §IX.C.3.[1pre]-[1e] (Ground 1C). As described above, although claim 10 is a method claim, the elements of claim 10 correspond substantively with the claim elements of claim 1 and are rendered obvious by Murakoshi-Stewart-Sachs-Orr for the same reasons presented above with regard to the elements of claim 1.

[10k-ii]-[10l]

308. Murakoshi-Stewart-Sachs-Orr renders obvious elements [10k-ii]-[10l] for the same reasons described above with regard to Ground 1A. *Supra* §IX.A.4.[10k-ii]-[10l] (Ground 1A). In particular, although Apple's constructions of certain terms in claim 1 and claim 10 differ from Haptic's constructions (and apparent understandings) for those terms, the mapping of Murakoshi-Stewart to the limitations of claim 10 [10k-ii] and [10l] presented in Ground 1A meet the limitations of claim elements [10k-ii]-[10l] under Apple's constructions.

309. In particular, Murakoshi's teaching that a control signal (command) indicates an operation of (terminal) device to be controlled (corresponds to activity of said terminal device) renders obvious Element [10k-ii] under Apple's construction. APPLE-1004, [0048] ("[t]he control signal indicates an operation of

the device 102 to be controlled in response to the interaction."), [0023] ("a control signal ***to switch on*** a lamp"), [0050] ("control signal may ***switch on and/or switch off*** the home appliance"). Under Apple's construction, a terminal device is a remote device, which is met by Murakoshi's teachings. §VIII (Claim Construction); *see e.g.*, APPLE-1006, [0023] ("switch on a lamp").

310. Additionally, Murakoshi's teaching that the terminal "device 102 may process the received control signal and perform the operation indicated by the control signal" renders obvious Element [10l] under Apple's construction. §VIII (Claim Construction); APPLE-1004, [0084], [0048], [0077].

c) Claims 2, 8-9

311. Murakoshi-Stewart-Sachs-Orr renders obvious claims 2, 8, and 9 for the same reasons described above in Ground 1A. *Supra* §§IX.A.4.[2], [8], [9] (Ground 1A). Although Apple's constructions of certain terms in claim 1 and claim 10 differ from Haptic's constructions or apparent understandings for those terms, the mapping of Murakoshi and Stewart to the limitations of claims 2, 8 and 9 presented in Ground 1A meet the limitations of claims 2, 8, and 9 under Apple's constructions.

d) Claims 4, 5, 11

312. Murakoshi-Stewart-Sachs-Orr renders obvious claims 4, 5 and 11 for the same reasons described above in Ground 1B. *Supra* §§IX.B.3.[4], [5], [11]

(Ground 1B). Under Apple's construction and in the Murakoshi-Stewart-Sachs-Orr combination, the processing of the vibratory signals, including additional processing details per Sachs, occur at the server as Orr teaches. Although Apple's constructions of certain terms in claim 1 differ from Haptic's constructions (or apparent understandings) for those terms, the mapping of Murakoshi, Stewart, and Sachs to the limitations of claims 4, 5, and 11 presented in Ground 1B meet the limitations of claims 4, 5, and 11 under Apple's constructions.

D. GROUND 2A: THE LI-IFIXIT COMBINATION RENDERS CLAIMS 1-2 AND 9-10 OBVIOUS

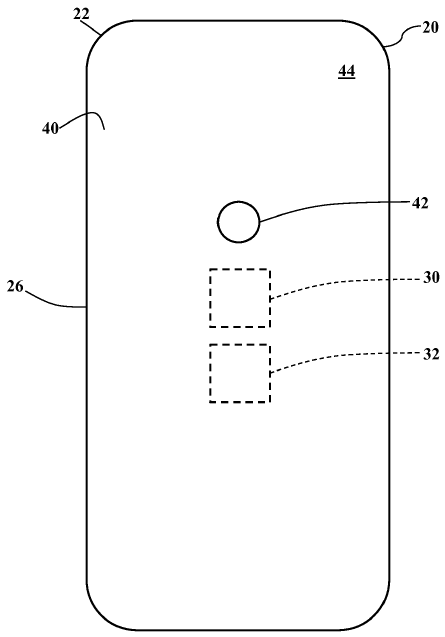
313. Discussion below covers Ground 2A under Haptic's constructions and apparent understandings of the claim terms based on the Joint Claim Construction statement and Haptic's infringement contention. *See generally* APPLE-1101; APPLE-1107. In the below discussion, I refer to Haptic's infringement contentions (APPLE-1101), as well as to the claim construction section above when necessary to explain Haptic's constructions and understandings of various terms.

1. Li

314. Li describes "an electronic device 20 that accepts touches, swipes, and other physical gestures as inputs." APPLE-1008, [0019]. Li's Figure 2 "illustrates a backside 40 of the electronic device 20 [including] a body 26 [which] includes a gesture detector 42 [that] detects physical gestures that are made on an outer

surface 44 of the body 26." *Id*., [0020]. "The user may make gestures on the outer surface 44 of the body 26, and the processor 30 interprets those gestures to control the electronic device 20." *Id*.

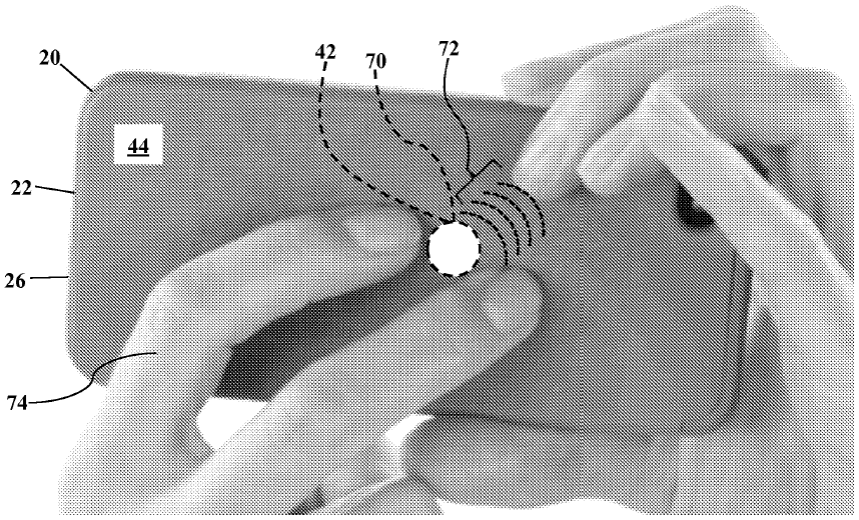
FIG. 2



APPLE-1008, Fig. 2

315. "As the user draws and/or taps the gesture 74 on the outer surface 44 of the body 26, vibration waves travel through or along the outer surface 44 of the body 26 [and the gesture detector's] piezoelectric transducer 70 senses the vibration 72." *Id*., [0023].

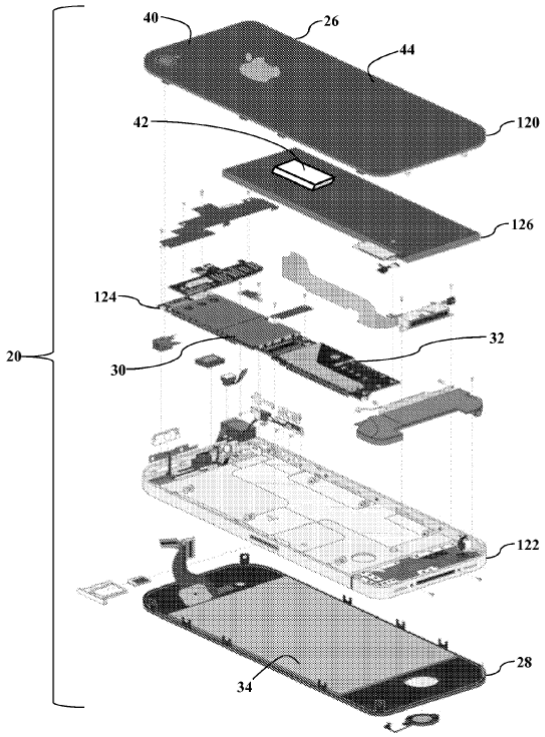
FIG. 4



APPLE-1008, Fig. 4

316. Li describes that, "[b]ecause the gesture detector 42 responds to physical gestures, the gesture detector 42 may be installed at any position or location on or in the body 26." *Id.*, [0027]. "As the gesture is drawn, the vibration 72 propagates through the body 26 as mechanical and/or acoustical waves … [t]he gesture detector 42 senses the vibration 72 and generates the output signal 52. *Id.*, [0030].

FIG. 15



APPLE-1008, Fig. 15

317. In Fig. 15, "[t]he electronic device 20 is illustrated as the popular IPHONE® manufactured by Apple, Inc." *Id*., [0033]. A POSITA would have recognized that this could be any iPhone with the necessary circuitry. Within the iPhone shown in Fig. 15, "[t]he gesture detector 42 may have an interface to the circuit board 124, such as a metallic strip or contact pad that conducts signals to/from the circuit board 124 [or t]he interface may also be a physical cable that plugs into a socket in the circuit board 124." *Id*. Li describes that "the gesture detector 42 senses the vibration … caused by gesture inputs on the body 26 [and] produces the output signal … in response to the vibration 72." *Id*.

"The processor 30 analyzes the output signal 52 and executes the corresponding command 58." *Id.*

318. Li describes that "[t]he processor 30 … executes a gesture algorithm 50 stored in the memory 32 [which] includes instructions, code, and/or programs that cause the processor 30 to interpret any gesture input sensed by the gesture detector 42." *Id.*, [0022]. "The processor 30 receives the output signal 52 [generated by the gesture detector based on the user gestures on the outer surface of the body] and queries a database 54 of gestures." *Id.* Li describes that "[t]he processor 30 compares the output signal 52 to the entries stored in the database 54 of gestures" and "[s]hould a match be found, the processor 30 retrieves the corresponding command 58." *Id.*

2. iFixit

a) iFixit Report is a prior art printed publication

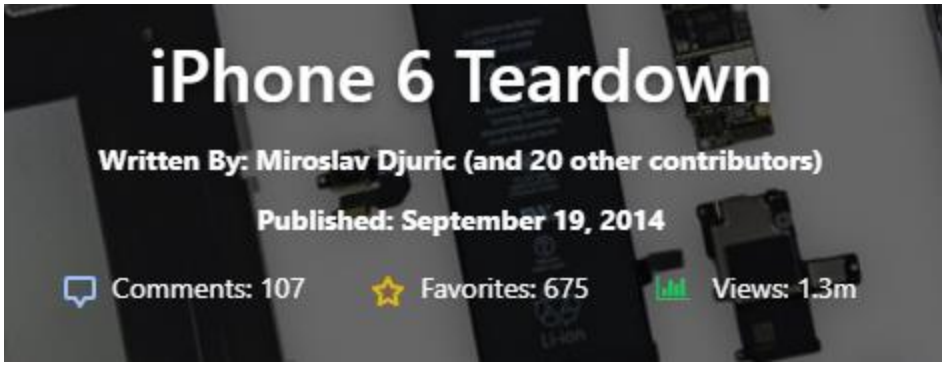
319. The iFixit Report (APPLE-1010) published on September 19, 2014, and was generally available and known to the relevant technical community before the earliest possible priority date of the '738 patent. APPLE-1031, 1, 15-19, 25-26, 45. My understanding is that a reference is a prior art printed publication if it was sufficiently publicly accessible—that is if before the Critical Date the reference was disseminated or otherwise made available to the extent that persons

interested and ordinarily skilled in the subject matter or art exercising reasonable diligence, can locate it.

320. iFixit's publications, including the iFixit Report, were disseminated to members of the public interested in maintaining and repairing consumer electronics and could be located by such interested members of the public, and is accordingly a printed publication. Further, as explained below, the iFixit Report could be located by interested members of the public because it was indexed on iFixit's website, accessible through internet search engines, and linked to various other websites.

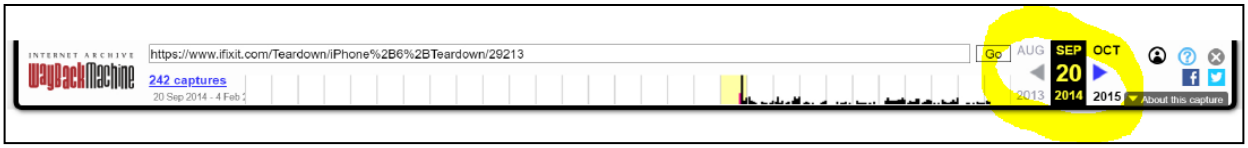
(i) ***The iFixit Report published September 2014***

321. The current version of the iFixit Report (APPLE-1010) expressly states that it "Published: September 19, 2014."



The archived version of the iFixit Report (APPLE-1011) corroborates this date. It was archived for the first time on September 20, 2014.

https://web.archive.org/web/20140920142624/https:/www.ifixit.com/Teardown/iPhone+6+Teardown/29213



APPLE-1031, 1, 45-46 (highlighted). The archived version of the iFixit Report includes comments posted "yesterday" (i.e., September 19, 2014). APPLE-1011; APPLE-1031, 45-46. The iFixit Report was published on the iFixit website and in a video posted to YouTube. *See e.g.*, APPLE-1010, APPLE-1011, APPLE-1032, APPLE-1027 (YouTube page for iFixit Video titled "The iPhone 6 Teardown Review"). Accordingly, iFixit was made available to interested persons as of at least September 2014.

(ii) ***A POSITA would have been familiar with iFixit and the iFixit Report***

322. By the Critical Date, iFixit was a popular and well-known website that sold repair parts and published free guides for repairing consumer electronics. I was personally familiar with iFixit.com at least by February 2011, which I know because at that time, I used that website to order a replacement battery and tools for my iPhone 3G (which I recall then successfully using to replace the battery on my iPhone). *See* Appendix B. Similarly, a POSITA would have been familiar with iFixit.com at least by March 2011 as evidenced by an email newsletter from the *New York Times* that I received in that period that linked to iFixit.com to describe various products. *See* Appendix C. The email—a digest of tech-related articles in the *New York Times*—included a link to an article titled "ifixit.com unpacks Xoom

and MacBook Pro." *Id.* Furthermore, I received an email at the University of Maryland in September 2013 that was sent to essentially the whole campus that linked to iFixit.com as a resource to help repair electronics. *See* Appendix D. My recollection is that in that time period (2011 – 2013), the existence of iFixit.com was common knowledge among the faculty, staff, and students that I worked with.

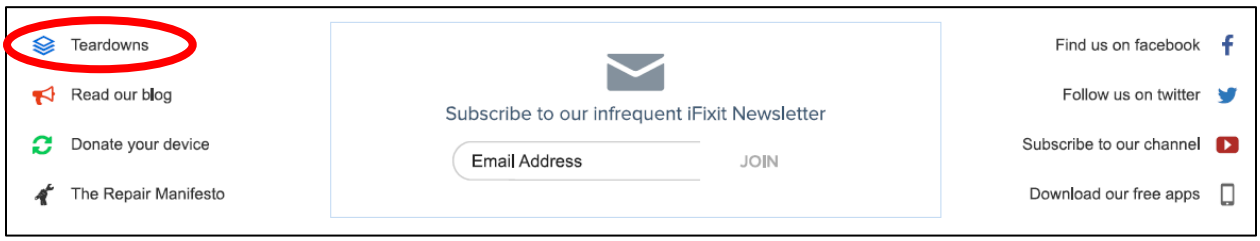
323. Not surprisingly, popular websites, including Yahoo Finance News, Yahoo News Canada, The Telegraph, Tech Radar, Ars Technica, Engadget, and CNET each published articles referencing the iFixit Report of the iPhone 6 and 6 Plus Teardowns. APPLE-1013; APPLE-1014; APPLE-1015; APPLE-1016; APPLE-1031, 10-12; APPLE-1017; APPLE-1018; APPLE-1019; APPLE-1020; APPLE-1021; APPLE-1022; APPLE-1023; APPLE-1024. The iFixit Report was also discussed on the well-known social news website Reddit in the popular "iPhone" subreddit. APPLE-1025; APPLE-1026.

324. The popularity of iFixit and the iFixit Report are further evidenced by iFixit's YouTube page, which included a video of the iFixit iPhone 6 teardown (titled "The iPhone 6 Teardown Review"). APPLE-1027 (archived YouTube page); APPLE-1028; APPLE-1031, 4-9. By September 22, 2014, the YouTube page already had 15,553 views and 100 interactions. APPLE-1027, 1; APPLE-1031, 1, 7-9. Just three months later, it had 92,229 views and 491 interactions. APPLE-1028; APPLE-1031, 1, 4-6. Indeed, by April 7, 2010, four years before

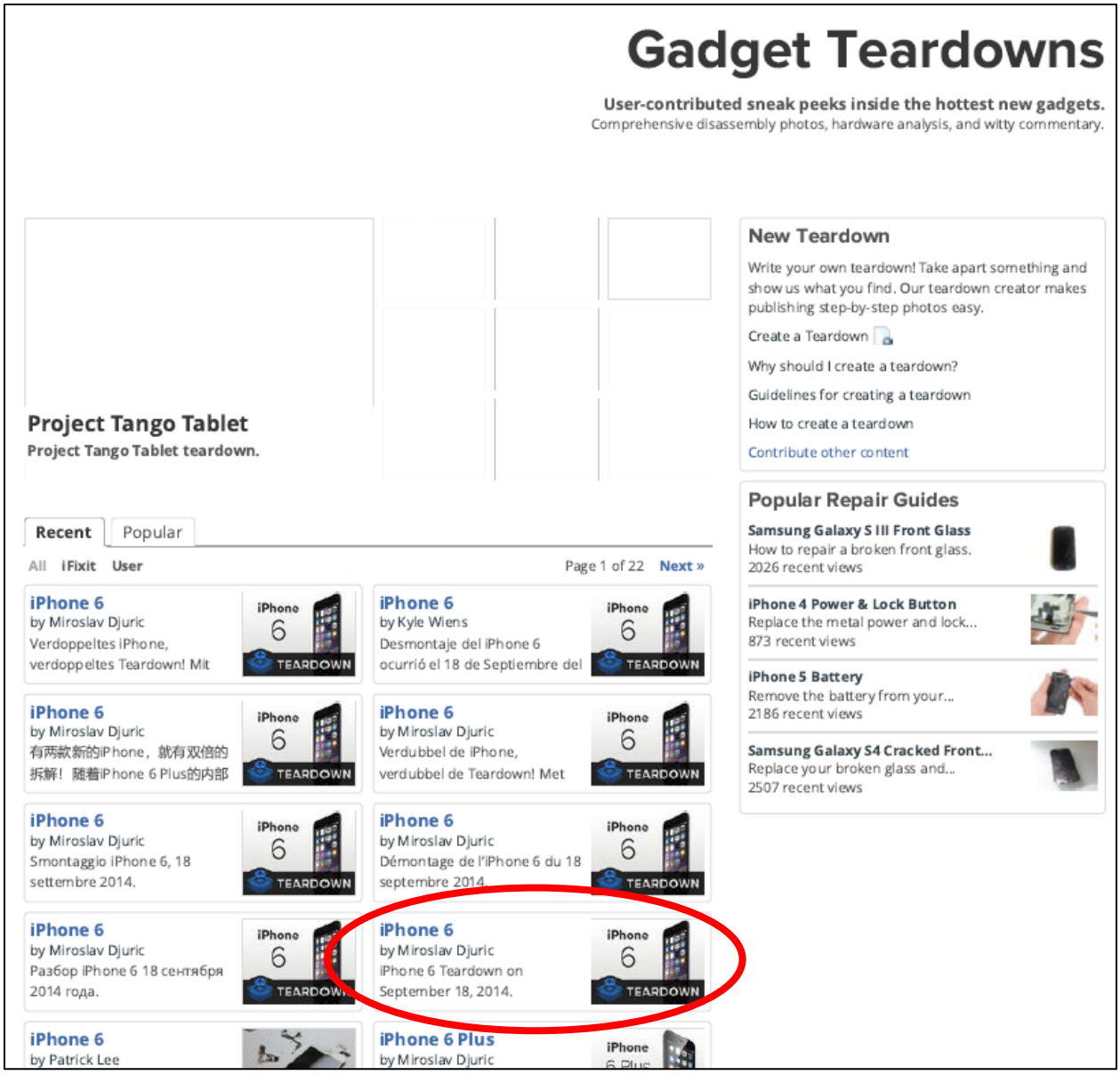
the iFixit Report published, iFixit had approximately 800 registered users. APPLE-1029; APPLE-1031, 1, 13-14. From the ubiquity of the iFixit website and mentions of its teardown reports by well-known news sources, it is clear that by the Critical Date a POSITA would have been familiar with iFixit and its teardown reports related to popular consumer electronics. In other words, a POSITA would have known of iFixit and would have been able to access iFixit, for example, through at least any of the aforementioned sources (e.g., YouTube, Reddit, news articles, etc.) in addition to directly visiting iFixit's website.

(iii) ***A POSITA would have been able to locate the iFixit Report because it was indexed***

325. The iFixit Report was freely available and widely disseminated via iFixit's website. *See* APPLE-1013 to APPLE-1028. The iFixit website was indexed such that a POSITA could navigate from the iFixit homepage to a "Gadget Teardowns" page to the iFixit Report.



APPLE-1032, 2 (annotated in red)



APPLE-1012, 1 (annotated in red)

Additionally, to understand the inner workings of these electronics, identify internal components (including repair parts), and obtain guides on repairing those devices, as iFixit was designed to provide, a reasonably diligent POSITA would have had reason to, and regularly did, navigate through the pages on the iFixit website to obtain teardown reports and repair guides. iFixit freely provided

resources including the iFixit teardown without requiring a user to log-in, register, sign an NDA or pay. APPLE-1032, 1 ("The free repair guide for everything").

326. On September 24, 2014, a POSITA could have easily navigated to the iPhone 6 Teardown report, because the iFixit.com homepage included a link to the report (APPLE-1032), and to the iPhone 6 Plus Teardown report which further linked to "the normal-sized iPhone 6 teardown" (APPLE-1033). An interested party could also navigate to the iFixit Report via any number of news articles published around the September 2014 date of the iFixit teardown report that discussed and provided a link to the iFixit Report of the iPhone 6 teardown. *See e.g.*, APPLE-1013 (9/19/2024 Yahoo News article linking to "a new teardown video of the iPhone 6"); APPLE-1017 (9/19/2014 TNW article linking to "iFixit" and to "a live teardown of the new jumbo-sized iPhone 6 Plus"); APPLE-1018 (9/19/2014 Ars Technica article linking to iFixit teardown of "iPhone 6"); APPLE-1019 (9/19/2014 Tech Radar article linking to iFixit); APPLE-1020 (9/18/2014 Engadget article linking to iFixit team's "go at a brand new iPhone 6 Plus"); APPLE-1022 (9/19/2014 Register article linking iFixit's report on "the iPhone 6"); APPLE-1023 (9/19/2014 CNET article linking iFixit's "latest teardowns on the new iPhone 6"); APPLE-1024 (9/19.2024 Techlicious article directing readers "If you want to learn more, you can read the full teardown description of the iPhone 6 and iPhone 6 Plus at the iFixit website"). Accordingly, a POSITA would have

been able to locate the iFixit iPhone 6 teardown report by a variety of easily navigable pathways.

327. For at least these reasons, the iFixit Report is a prior art printed publication.

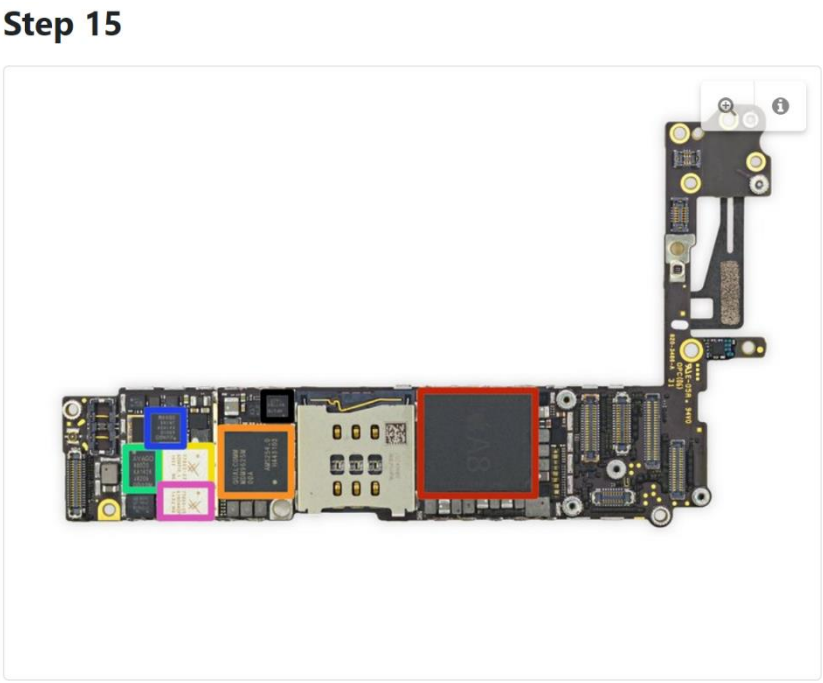
b) iFixit Teardown Report

328. As described above, iFixit is a teardown report of an iPhone 6, providing details about the internal components of the phone and how to access them. APPLE-1011, 1. For example, iFixit illustrates the use of a Phillips screwdriver to remove screws holding the logic board in place against the back cover of the iPhone. *Id.*



APPLE-1011, 4

As shown below, iFixit further illustrates the components found on the front side of the logic board, including an "InvenSense MP67B 6-axis Gyroscope and Accelerometer Combo." *Id.*, 6-7 (InvenSense component outlined in black).



APPLE-1011, 6-7

3. Li-iFixit Combination

a) The Combination

329. In Li-iFixit, Li's gesture detection methodology is implemented in an iPhone using internal components of an iPhone identified in iFixit. APPLE-1007, [0019]-[0020], [0033]-[0035], Fig. 15; APPLE-1011, 1, 6-7. Li's methods for detecting gestures using a "gesture detector" are implemented in an iPhone (based on Li's suggestion to do so) and using the accelerometer that already is within the iPhone, as iFixit teaches.

330. Li describes a gesture detection methodology, and instructs the reader that "gesture detector 42 may be disposed anywhere within the electronic device 20," but requires "an interface to the circuit board 124." APPLE-1008, [0035]. A POSITA would understood from Li's disclosure that the gesture detector can be implemented in a variety of locations in electronic devices, including smartphones like the iPhone given as an example in Fig. 15. *Id.*, [0019], [0033], Fig. 15. A POSITA would have understood that Li depicts the gesture detector in an iPhone as an example of how the methodology might be applied to various electronic devices. *Id.*, Fig. 15. A POSITA would have understood that Li's gesture detection methodology could be implemented in a variety of electronic devices and smartphones.

331. To understand how to implement and position the gesture detector, per Li, within the electronic device, a POSITA would have looked to references describing the internal structures and components of smartphones. APPLE-1008, [0033], [0035], Fig. 15. A POSITA would have looked to references such as iFixit that describe the internal components, structure, and layout of smartphones, such as an iPhone, to determine an appropriate placement of the gesture detector. APPLE-1011, 1. Based on Li's depiction and description of the use of an iPhone, a POSITA would have been motivated to look to references describing iPhone

internal structures and components to understand the details of how to implement Li's method – for example iFixit.

332. Additionally, in Li-iFixit, the iPhone includes an accelerometer mounted on the logic board, which is held in place in the iPhone body by screws, and is used to sense vibrations per Li. APPLE-1011, 6-7, 3-4, 9-10.

333. A POSITA, viewing iFixit, would have understood that versions of the iPhone, including iPhone 6, included an accelerometer, and would have understood that an accelerometer, such as the accelerometer of the iPhone 6, could be used to detect the vibrations that Li's gesture detector senses. For example, Li describes that "the gesture detector 42 may be any device" and gives an example of a piezoelectric transducer that can detect and "respond to vibration 72 sensed in, on or around the body 26" of the electronic device. APPLE-1008, [0023]. A POSITA would have understood that an accelerometer is also a type of sensor that can detect vibrations. *See supra* §VI.B.3. Moreover, a POSITA would have understood that the piezoelectric transducer described by Li is an accelerometer because it is a device that measures acceleration. *See* APPLE-1008, [0023] ("The gesture detector 42 may thus utilize the piezoelectric effect to respond to vibration 72 sensed in, on, or around the body 26"); APPLE-1041, 3 ("The force experienced by the piezoelectric crystal is proportional to the seismic mass times the input acceleration"), 27 ("Accelerometers are sensing transducers that provide

an output proportional to acceleration, vibration and shock"), 28 ("The piezoelectric accelerometer is an acceleration sensor").

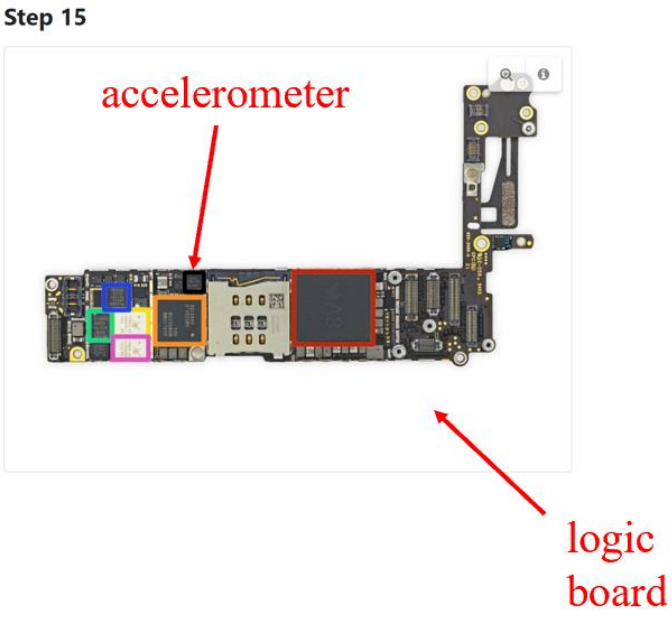
334. A POSITA would have therefore been motivated to implement a gesture detector, per Li, in an accelerometer, disclosed in iFixit, to detect vibrations, just as Li describes. APPLE-1008, [0023]. A POSITA would have understood that the accelerometer within the iPhone, as taught by iFixit, may be used to detect vibrations and generate an output signal in response as Li teaches. *Id.* A POSITA would have understood that because the iPhone includes an accelerometer that may be used for the gesture detection, there is no need to position an additional gesture sensor within the iPhone. *See* APPLE-1011, 6-7; APPLE-1008, Fig. 15. Although Li depicts an exploded view of an example iPhone with a gesture detector 42 added to the components (*see* APPLE-1008, Fig. 15), a POSITA would have recognized that using the existing accelerometer would not require additional components to be added to the phone and would maintain the form factor of the smartphone.

335. Moreover, it would have been obvious in view of iFixit, to use the existing accelerometer of the iPhone detect vibrations from user gestures on the device as Li teaches because the existing accelerometer interfaces with the logic board and meets the requirements for positioning of the sensor that Li sets out. APPLE-1008, [0035]. A POSITA would have understood that the accelerometer

of the iPhone is an existing sensor for detecting vibrations that interfaces with the logic board (which is near the back surface of the iPhone where taps or gestures would be input by a user) and can sense vibrations on the back of the iPhone. *Id.*, [00235], [0023].

336. Li does not explain how the components within the phone (e.g., logic board, battery, etc.) are mounted to the body of the phone. APPLE-1008, Fig. 15. Li's Fig. 15 shows an exploded view of an iPhone, but does not include details about the positioning and connections between the components. A POSITA, reading Li, would have looked to references such as iFixit to understand how the components and structures, including the logic board, are held within the iPhone body. APPLE-1011, 3-10. iFixit teaches that the iPhone 6 includes an accelerometer mounted on the logic board and that the logic board is held in place by screws. APPLE-1011, 6-7, 3-4, 9-10. iFixit identifies the accelerometer on the logic board, explaining in Step 15 that "[t]he front side of the logic board" includes an "InvenSense MP67B 6-axis Gryoscope and Accelerometer Combo" (annotated in the figure below). APPLE-1011, 6-7. Additionally, iFixit describes the removal of Phillips screws from the internal components to remove them from the phone casing (e.g., "there are certainly Phillips screws on the inside [of the phone] and "With screwdriver in hand, we tackle the metal bracket screws that secure the front panel assembly in place"). *Id.*, 4. Additionally, a POSITA would have understood

that screw holes are visible in the edges of the logic board as depicted in iFixit. *See id.*, 6-8.



APPLE-1011, 6-7

337. As described above, a POSITA, motivated to combine Li and iFixit, would have done so by using an accelerometer, disclosed by iFixit as being positioned on the logic board, as the gesture detector in a mobile device (e.g., iPhone), per Li. APPLE-1008, [0033], Fig. 15; APPLE-1011, 6-7. A POSITA would have understood that it was advantageous to use the accelerometer already positioned on the logic board of the device to detect vibrations because making use of an existing phone component and its conventional placement on the logic board would mean that there was no need to add an additional sensor component to the phone body to achieve the functions that Li teaches.

b) Reasons for the Combination

338. A POSITA would have understood that Li describes that "the gesture detector 42 may be any device," and an accelerometer, such as the "InvenSense MP67B 6-axis Gyroscope and Accelerometer Combo" disclosed by iFixit as being already present in the iPhone, would have been capable of "sens[ing] the vibration" and "generat[ing] the output signal…in response to the vibration" as Li requires of the gesture detector. APPLE-1008, [0023].

339. A POSITA would have been motivated to pursue the Li-iFixit combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

340. First, a POSITA would have been motivated to look to the components and systems within the iPhone to implement Li's system based on Li's suggestion to implement the gesture detection system as an accelerometer in an iPhone. APPLE-1008, [0023] (describing that a gesture detector may be a piezoelectric transducer for detecting vibrations), Fig. 15, [0033]; APPLE-1041, 27 (describing that "[a]ccelerometers are sensing transducers that provide an output proportional to acceleration, vibration and shock"). Li illustrates the system using an iPhone in Figure 15 and explicitly states that "[t]he electronic device 20 is illustrated as the popular IPHONE ® manufactured by Apple, Inc." APPLE-1008, [0033]. A POSITA would have understood from Li's disclosure that the iPhone is

presented as an example system in which the gesture detection method can be implemented, but would have been motivated to use the iPhone as the smart phone device given Li's specific reference to it. *Id.* Given Li's directive to implement the system in an iPhone, a POSITA would have been motivated to look to references like iFixit that describe the internal components of the iPhone to implement Li's system.

341. Second, a POSITA would have understood from Li's disclosure that the gesture detection method could be implemented in a variety of different electronic devices. For example, Li describes the method in an "electronic device" which "may be any processor-controlled device" (APPLE-1008, [0019]) including "mobile smartphones and tablet computers" (APPLE-1008, [0002]). Additionally, Li describes the system's use with a generic "smartphone." *Id.*, [0019]. As described above, Li's description of the iPhone as an example would have motivated a POSITA to look to references like iFixit to understand the components of the iPhone to implement gesture detection in an iPhone as the specific smartphone device described in Li. *Id.*, [0019]-[0020], [0033]-[0035], Fig. 15.

342. Third, a POSITA would have understood that an accelerometer is a sensor (e.g., the accelerometer described by iFixit as being present in the iPhone) that is capable of "sens[ing] the vibration" and "generat[ing] the output signal…in response to the vibration." APPLE-1008, [0023]; APPLE-1041, 27; *supra*

§VI.B.3. Li describes that a variety of sensors can be used in the gesture detection method, and describes a piezoelectric sensor in particular for detecting the vibrations. APPLE-1008, [0023]. A POSITA would have been aware that accelerometers are conventionally used to detect vibrations, would have understand the piezoelectric transducer of Li to be an accelerometer because it senses vibrations (accelerations), and would have been motivated to implement Li's teachings of a gesture detection method using the existing accelerometer already within the iPhone, as evidenced by iFixit. APPLE-1011, 6-7; APPLE-1008, [0023].

343. Fourth, a POSITA would have been motivated to implement Li's gesture detection method using an existing accelerometer positioned within an iPhone, as iFixit illustrates, as the sensor for detecting vibrations in the Li-iFixit combination because doing so would maintain the existing form factor of the phone, compared to any solution that would require adding additional components to the phone (e.g., compared to adding a separate gesture detector to the iPhone as depicted in Li's Fig. 15). A POSITA would have been aware that commercial smartphones include hardware and electronic modules that are packaged very carefully with small tolerances to optimize the smartphone's form factor (e.g., size and shape). *See* APPLE-1011, 1 ("at 4.7", [the iPhone 6 is] still a giant among iPhones… [w]hat was so big that Apple couldn't fit it into the familiar form

factor?"). A POSITA would have understood that there is very little "empty" or "free" space within most commercially available smartphones, and this understanding would have been reinforced by references like iFixit that take apart smartphone devices and depict the internal structures. *See* APPLE-1011, 4 (showing components of the iPhone after removal of the front panel), 5-9. Using the existing accelerometer within the iPhone body for detection of vibrations to be used in Li's gesture detection method uses existing components already in the iPhone and maintains the iPhone's form factor and size. *Id.*

344. Fifth, a POSITA would have understood that using the existing accelerometer already present in the iPhone (as iFixit illustrates) achieves Li's requirements of having the gesture detector interface with the logic board and be located close to the back of the iPhone to detect taps and gestures on a back surface. APPLE-1008, [0033], Fig. 15; APPLE-1011, 6-7. Li's Figure 15 illustrates an example in which a sensor (gesture detector 42) is "integrated into the assembly, proximate the bottom portion 120 of the body 26" and is positioned in the figure on battery 126. APPLE-1008, [0033], Fig. 15. A POSITA would have understood that the exploded view of the iPhone in Li's Figure 15 is an example of the placement of a sensor within a phone, based on Li's teaching that the sensor "may thus be installed at any location of the body 26 to detect the vibration 72 caused by gesture inputs." *Id.*, [0028]. A POSITA would have understood that a

gesture sensor can be positioned within a phone, but that existing sensors within a smartphone, such as an iPhone, may also be used to detect vibrations for use in Li's gesture detection method.

345. Based on iFixit's teaching that the iPhone includes an "InvenSense MP67B 6-axis Gryoscope and Accelerometer Combo," a POSITA would have been motivated to make use of the existing accelerometer within the iPhone, and would have understood that the existing accelerometer described by iFixit would operate to detect vibrations just as Li teaches, further offering evidence that a POSITA would have had a reasonable expectation of success in the combination. APPLE-1011, 6-7; *see also e.g.,* APPLE-1008, [0023], [0027]-[0028]. The accelerometer within the iPhone is mounted on the logic board and thus includes "an interface to the circuit board" as Li instructs. APPLE-1008, [0033]; APPLE-1011, 6-7. A POSITA would have understood that the existing accelerometer within the iPhone, located on the logic board, would have met the requirements for positioning of the sensor that Li describes, and thus would have been able to sense vibrations on the body of the phone in the gesture detection method, per Li. APPLE-1008, [0033].

346. Sixth, a POSITA would have been motivated to incorporate iFixit's teaching of an accelerometer mounted on a circuit board being held within the phone with screws in the context of Li because the accelerometer shown in iFixit is

already present on the phone's logic board and does not require an additional component to be added to the device. APPLE-1008, [0033], Fig. 15; APPLE-1011, 6-7. As described above, a POSITA would have looked to iFixit as a reference showing the actual internal components of the iPhone. APPLE-1011, 1. Using the existing accelerometer to detect vibrations as Li teaches would have been a simpler solution that positioning an additional sensor within an iPhone or connecting an additional sensor positioned on an outer surface to the iPhone's logic board. APPLE-1008, [0033], Fig. 15; APPLE-1011, 6-7. Using the existing accelerometer requires no changes to the existing structures and internal layout of the iPhone and would have been implemented by a POSITA using code rather than any additional hardware in the iPhone. Additionally, using a component already within the iPhone for detecting vibrations would decrease cost of implementing a system, as in Li, compared to adding an additional sensor to commercial smartphones. Because the gesture detection system is implemented simply through code controlling existing hardware (e.g., the iPhone's accelerometer) no additional components need to be purchased and installed. If the system required an additional component, the component would likely have a not insignificant cost associated with the design of a component that could be fit into the tight packaging of the iPhone body. Using the existing accelerometer avoids this potential cost.

347. Seventh, a POSITA would have understood that implementing iFixit's teachings to use the existing iPhone accelerometer to implement a gesture detection method as taught by Li would have yielded predictable results from combining known elements according to known methods. As described above, a POSITA would have understood the functions of an accelerometer (*supra* §VI.B) and would have understood that using the iPhone's accelerometer for detection of vibrations would have been a conventional use of the accelerometer. A POSITA would have further understood that using the signals sensed by the iPhone accelerometer, as taught by iFixit, to detect and identify the user gesture, as Li teaches, would predictably yielded the claimed invention, under Haptic's constructions and apparent understandings of the claim terms. Both references describe a system that uses components implemented within an iPhone, including a sensor for detecting vibrations. APPLE-1008, [0033], Fig. 15; APPLE-1011, 6-7. Li suggests the use of a "gesture detector" and iFixit depicts the accelerometer already mounted on the logic board within the iPhone. APPLE-1008, [0033], Fig. 15; APPLE-1011, 6-7. It would have been obvious to a POSITA that the gesture detection methodology described by Li would have been implemented in an iPhone with the structures depicted in iFixit based on Li's suggestion to use an iPhone and the similar disclosures of smartphone structures for detecting vibrations in the two references. Each element in the combination performs a similar function as it does

separately. A POSITA would have understood that implementing Li's gesture detection method in the iPhone does not require any extraordinary use of the accelerometer – just the typical accelerometer function of detecting vibrations. *Supra* §VI.B.3. A POSITA would have also understood that the methods Li describes could be implemented in the iPhone through the use of software, codes and algorithms. Applying and combining these concepts would have been obvious from a POSITA's perspective, and a POSITA would have had a reasonable expectation of success in doing so, for all of the reasons listed above. A POSITA would have further had a reasonable expectation of success in implementing Li's gesture detection method using the accelerometer of an iPhone per iFixit based on Li's suggestion to do so (APPLE-1008, Fig. 15, [0033]) and based on a POSITA's understanding of the basic functions of accelerometers. *Supra* §VI.B.3.

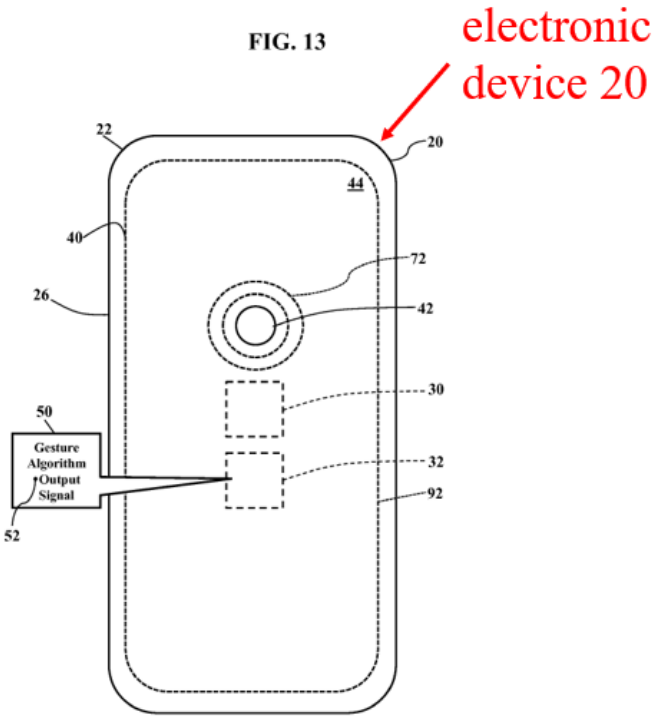
4. Element-by-Element Analysis

a) Claim 1

[1pre] A control system comprising:

348. To the extent the preamble is limiting, Li discloses a control system (electronic device 20, which can be an iPhone). APPLE-1008, [0019]-[0023], [0033], Fig. 4, 13, 15. As will be described below with regard to the limitations of claim 1 further defining the claimed "control system," Li describes a gesture detection method that can be implemented in a smartphone device to control

applications or components of the device. APPLE-1008, [0020]. In the Li-iFixit combination, the method is implemented in an iPhone, per iFixit, and the accelerometer in the iPhone detects vibrations to control aspects of the iPhone. As explained in Li, "[t]he user may make gestures on the outer surface 44 of the body 26 [of electronic device 20], and the processor interprets those gestures ***to control*** the electronic device 20." *Id.*, [0020] (emphasis added); *see also* [0019], Abstract.



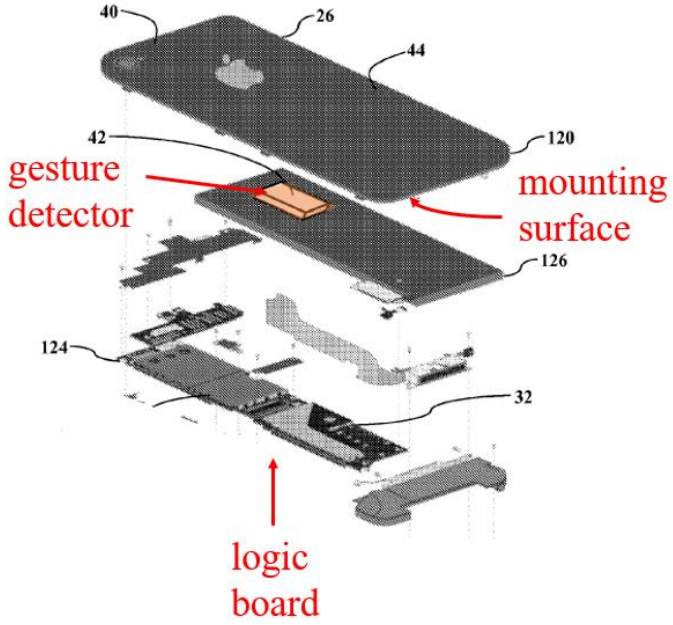
APPLE-1008, Fig. 13 (annotated)

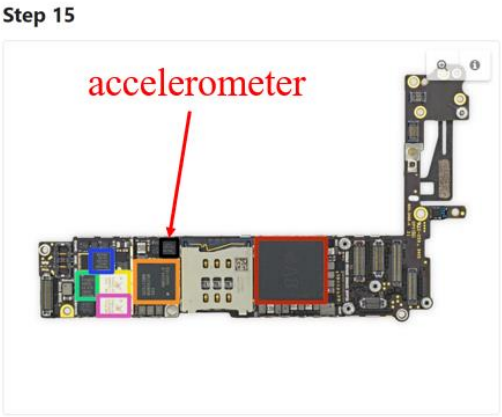
[1a] a housing having an engagement means for a mounting surface;

349. Li-iFixit renders this element obvious under Haptic's construction of "engagement means," consistent with Haptic's apparent understanding of the

limitation as evidenced by the infringement contentions. APPLE-1101, 9-12, 43-46.

350. Applying Haptic's apparent understanding of "engagement means," Li-iFixit renders obvious an "engagement means" based on Li-iFixit's logic board assembly (including at least the printed circuit board and the chips mounted on the logic board assembly) and Li-iFixit's housing (logic board assembly) coupled to a part of the iPhone that engages with the housing, including an inside surface of the iPhone's back cover. APPLE-1011, 6-7; APPLE-1008, Fig. 15, [0033]; §VIII (Claim Construction).



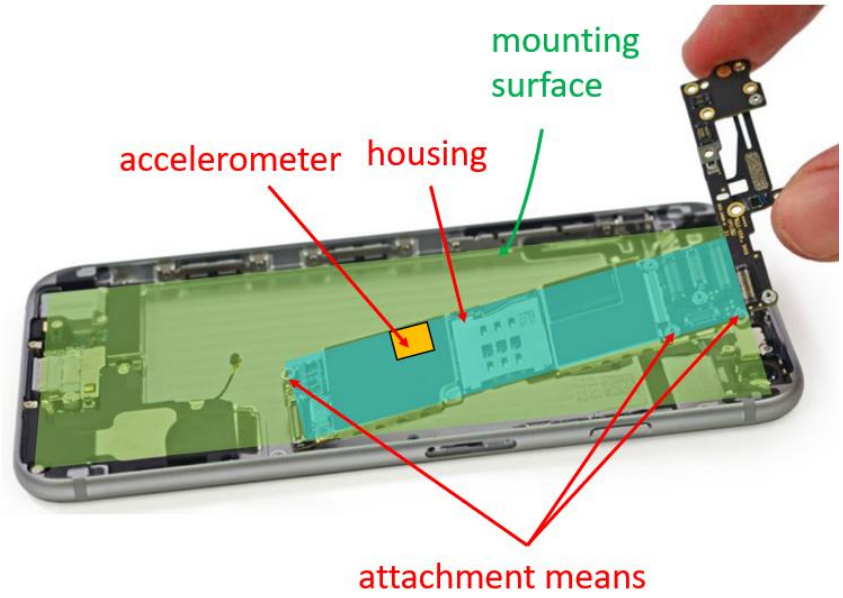


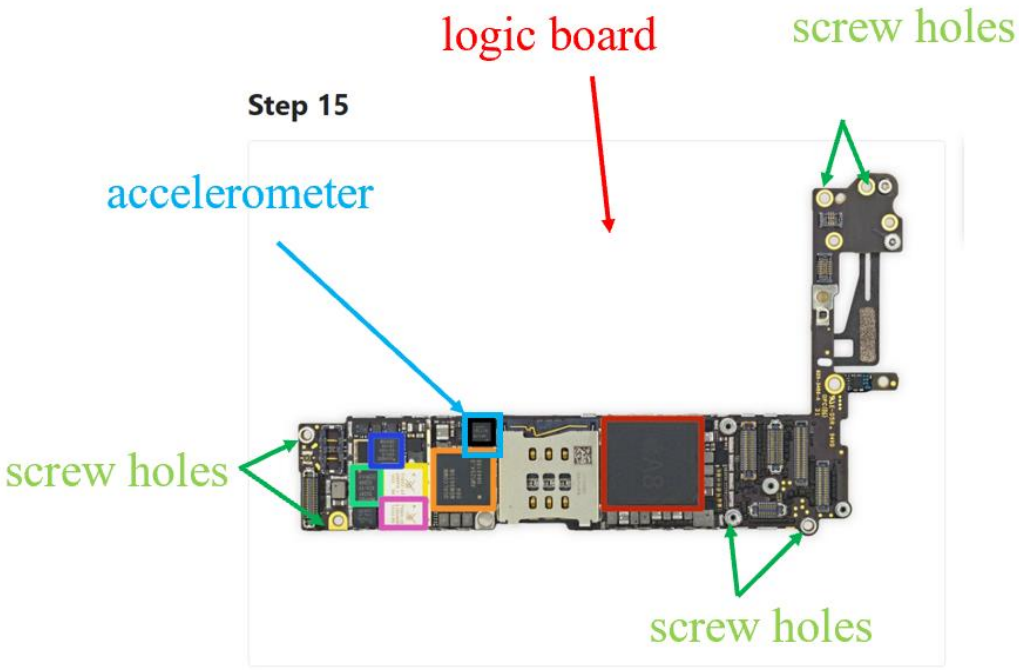
APPLE-1008, Fig. 15 (left); APPLE-1011, 6-7 (step 7) (right)

351. This mapping is consistent with Haptic's construction and apparent understanding as evidenced by Haptic's infringement contentions. APPLE-1101,

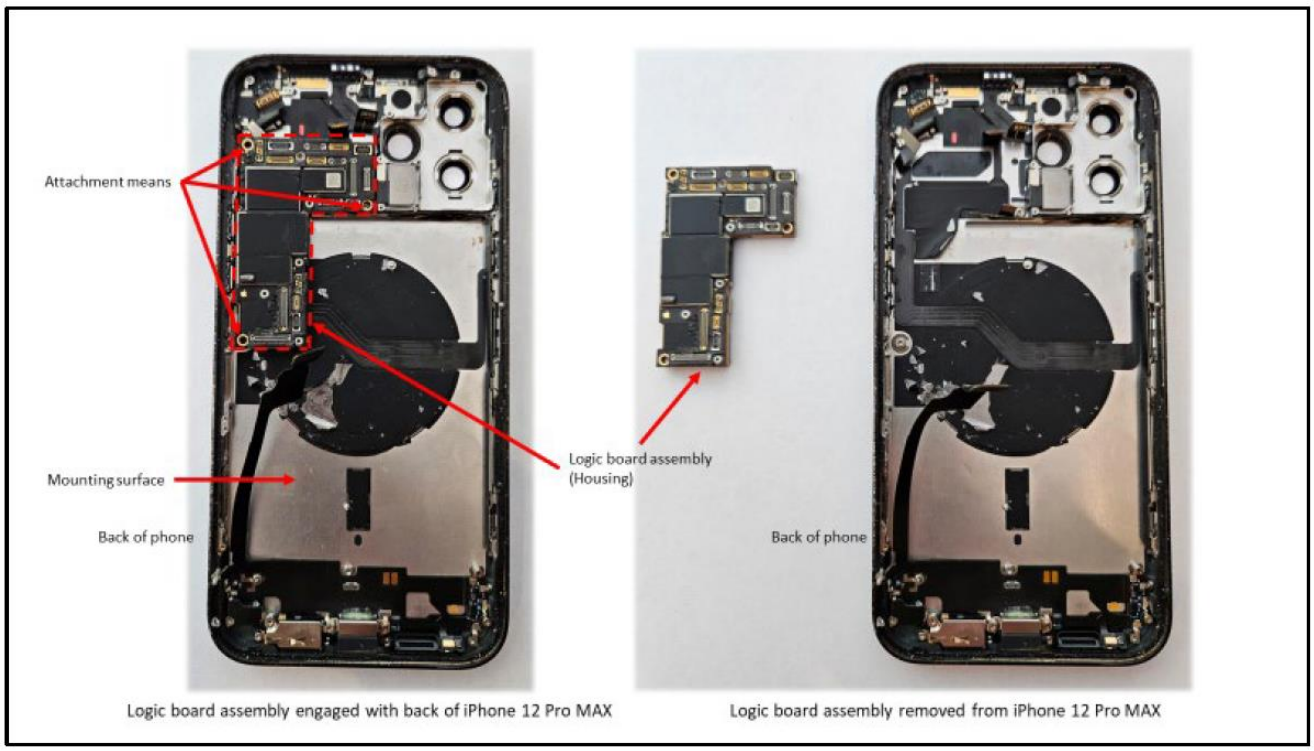
9-12, 33-35, 43-45, 66-68. For example, under Haptic's interpretation of the housing and mounting surface, the term housing is broad enough to encompass a logic board assembly on which a sensor is positioned. APPLE-1101, 9, 43. Further, the mounting surface, under Haptic's interpretation as evidenced by their infringement contentions, is broad enough to encompass a part of the inside cover of the iPhone that engages with the logic board assembly (housing). APPLE-1101, 9-12, 43-45.

352. Accordingly, Li-iFixit's housing (logic board assembly) is coupled to a part of the iPhone that engages with the housing, including an inside surface of the back cover of the iPhone. APPLE-1008, Fig. 15, [0033]; APPLE-1011, 6-7.





APPLE-1011, 5 (annotated) (left), 6-7 (annotated) (right)



APPLE-1101, 10 (image from Haptic's infringement contentions)

353. As described above (§VIII), under Haptic's construction the term "engagement means" is a means plus function term with the functions of engagement, attachment or holding the housing to the mounting surface, and connecting the sensor to the mounting surface. The corresponding structure is an "attachment means" and a "transmission portion;" adhesive, mechanical fasteners, threaded screws, screw holes, or other components to hold the housing to the mounting surface; and a portion connecting the sensor to the housing, which can be comprised of frames, brackets, a spring loaded portion, or a material with flexibility different than the materials of the mounting surface or surface of the contact interaction; and equivalents thereof. APPLE-1107, 8-10. Li-iFixit meets

Haptic's construction of "engagement means"—and is consistent with Haptic's apparent understandings of the term based on the infringement contentions—for the reasons explained below. A detailed §112(f) analysis for the "engagement means" element is provided below in Element [1e], which recites additional limitations relating to the "engagement means."

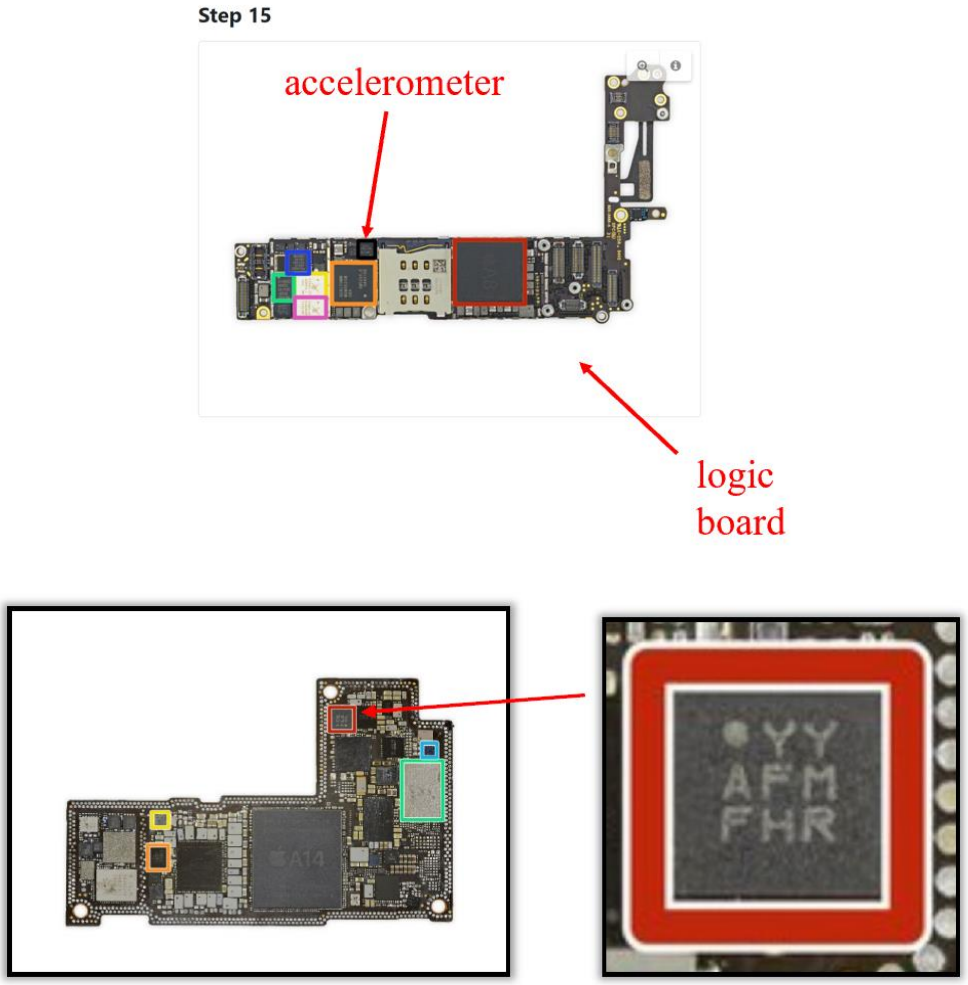
354. Li-iFixit renders obvious an "engagement means" by providing threaded screws and screw holes through the logic board assembly for attaching the logic board assembly within the iPhone, consistent with Haptic's apparent understanding as evidenced by the infringement contentions. APPLE-1101, 12, 46. Li's Figure 15 depicting an exploded view of an example iPhone illustrates dotted lines showing where screws are used to connect the components and structures to one another. APPLE-1008, Fig. 15. Additionally, iFixit explains that the internal structures of the iPhone are held in place by screws. APPLE-1011, 4 ("there are certainly Phillips screws on the inside [of the iPhone]"), 6-7 (showing logic board with holes for screws). Li-iFixit provides that the logic board assembly (housing) is coupled to the mounting surface using screws (i.e., "attachment means"), consistent with Haptic's construction and understanding as evidenced by their infringement contentions. APPLE-1101, 9-12, 43-46. Li-iFixit also provides that the accelerometer is positioned on the logic board and that the logic board connects the accelerometer to the screws that hold the logic board in

place (i.e., "transmission portion") within the phone and relative to the back cover of the phone, "), consistent with Haptic's understanding of the claim terms as evidenced by their infringement contentions. APPLE-1011, 5, 6-7, 9-10; APPLE-1101, 9-12, 43-46.

[1b-i] a sensor contained within said housing,

355. The Li-iFixit combination includes a sensor (InvenSense MP67B 6-axis Gyroscope and Accelerometer Combo) positioned on the logic board (contained within the housing), consistent with Haptic's infringement contentions. APPLE-1008, Fig. 15, [0023], [0033]; APPLE-1011, 6-7. Haptic's infringement contentions map the housing to the "logic board assembly that contains the sensor" (APPLE-1101, 9, 43). iFxit depicts that the accelerometer of the iPhone is positioned on a logic board. APPLE-1011, 6-7.

356. A POSITA would have understood that an accelerometer is a type of sensor. *Supra* §VI.B.3. Accelerometers, as explained above, detect changes in acceleration – such as are caused by vibrations. Accordingly, a POSITA would have understood that the accelerometer taught by iFixit is a sensor, and that it is contained within a housing because it is on a logic board, consistent with Haptic's interpretation of the word "housing" as evidenced by the infringement contentions. APPLE-1101, 9, 43.



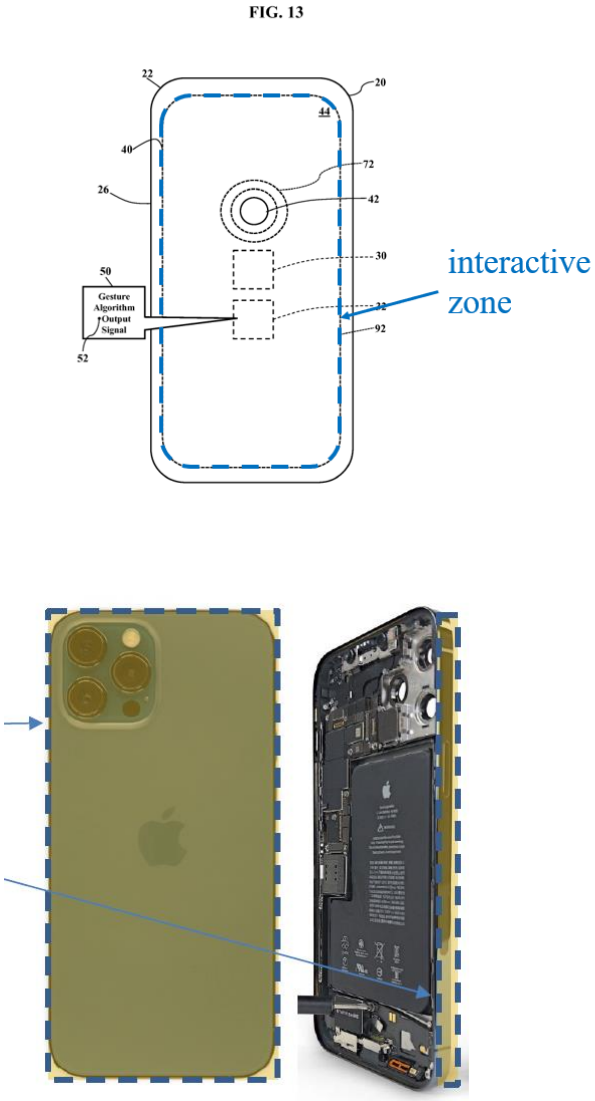
Top: APPLE-1011, 6-7 (annotated)

Bottom: APPLE-1101, 13 (image from Haptic's infringement contentions)

[1b-ii] said sensor forming an interactive zone defined by a range of said sensor,

357. The Li-iFixit sensor forms an interactive zone (supplemental gesture surface area 92) defined by a range of the sensor. Li discloses that "[t]he gesture detector 42," which is implemented using an iPhone accelerometer in the Li-iFixit combination, "detects physical gestures that are made on an outer surface 44 of the body 26." APPLE-1008, [0020]. Li further discloses that "[a]s the backside 40 [of

the phone] may present a large, supplemental gesture surface area 92 for inputting gestures, the gesture detector 42 may be disposed in or near the central region 90 to detect the vibration 72." APPLE-1008, [0027], [0030]. A POSITA would have understood that the supplemental gesture surface area described by Li "for inputting gestures" is a zone in which user interactions (e.g., input gestures) can be detected by the vibration sensor in the gesture detection method. Accordingly, a POSITA would have understood the supplemental gesture surface is an interactive zone as claimed. Further, in Li-iFxit, an accelerometer is able to detect the gestures made on the back surface of the phone because the vibrations on the back of the phone are within the accelerometer's range of detection. *See* APPLE-1008, [0023], [0033]. Accordingly, Li describes that the supplemental gesture surface area defines a zone in which the sensor can detect vibrations from user gesture inputs, consistent with Haptic's apparent understanding of the limitation as evidenced by the infringement contentions.



Left: APPLE-1008, Fig. 13 (annotated); Right: APPLE-1101, 14 (image from Haptic's infringement contentions)

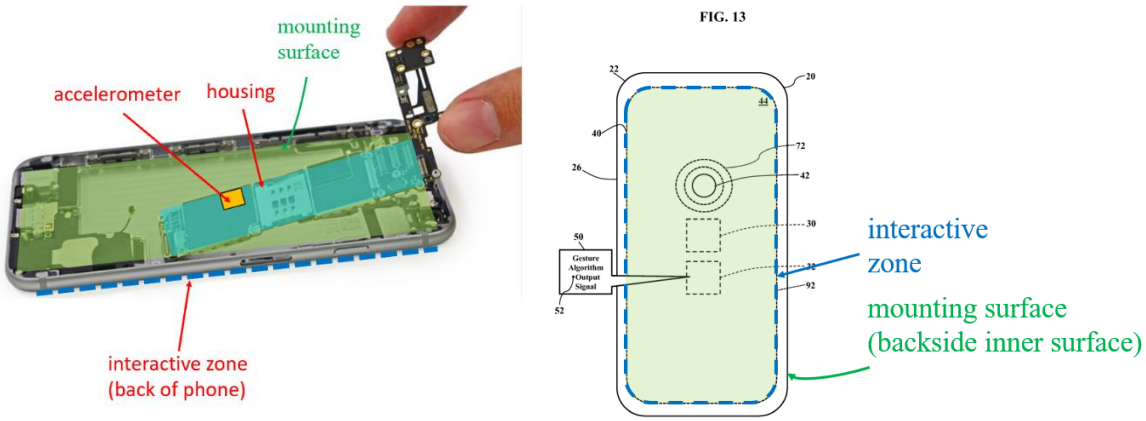
[1b-iii] said sensor being comprised of an accelerometer,

358. Li-iFixit's sensor comprises an accelerometer. APPLE-1011, 6-7; APPLE-1008, [0023]; APPLE-1041, 27. In particular, iFixit describes that an iPhone includes an accelerometer, for example an "InvenSense MP678 6-axis

Gyroscope and ***Accelerometer*** Combo." *Id*. As described above, a POSITA would have understood an accelerometer to be a type of sensor capable of detecting vibrations, and would have understood that Li's gesture detector is or can be an accelerometer. *Supra* §VI.B.3.

[1b-iv] said interactive zone being aligned with said mounting surface and overlaying said mounting surface outside a perimeter of said housing,

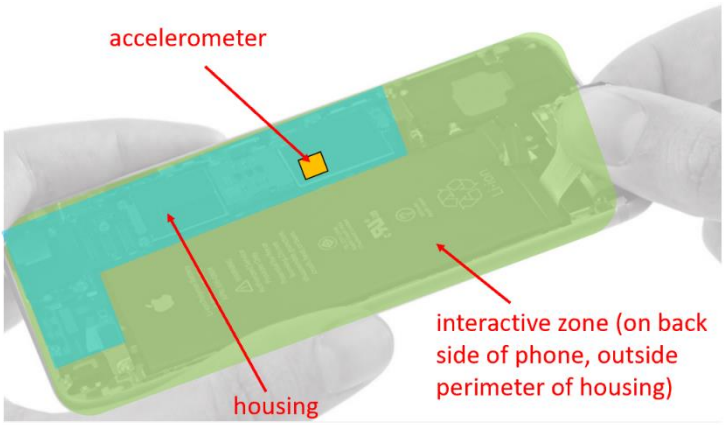
359. Li-iFixit's interactive zone (Li's supplemental gesture surface area 92) is aligned with the mounting surface, consistent with Haptic's apparent interpretations of this claim limitation as evidenced by the infringement contentions. APPLE-1008, [0030], Figs. 13, 15; APPLE-1101, 12, 15-16, 46, 50-51. Per its infringement contentions, Haptic interprets the mounting surface as broad enough to include the part of the iPhone that engages with the housing. APPLE-1101, 12, 46. Haptic also interprets that the mounting surface on the inside back cover of the phone, as evidenced by its infringement contentions, is aligned with the interactive zone on the back side or sides of the iPhone, where the interactive zone overlays the mounting surface. *Id.*, 15-17, 50-51. As illustrated in the figures from Li and iFixit below, the interactive zone on the back of the phone and the mounting surface on the inside of the back panel of the phone are located on two sides of the same back cover and lie in parallel planes, and are accordingly aligned under Haptic's interpretation.

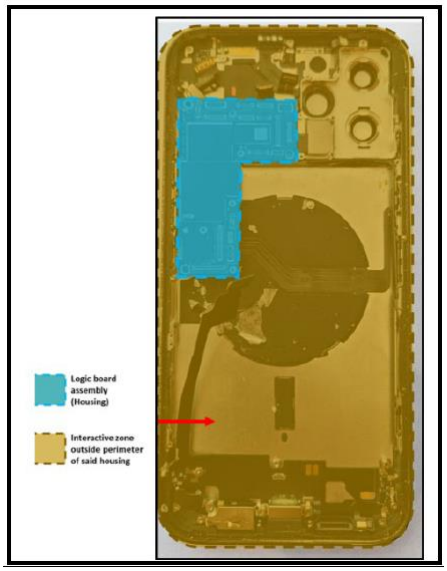


Left: APPLE-1011, 6 (step 14) (annotated)

Right: APPLE-1008, Fig. 13 (annotated)

360. Under Haptic's understanding of the claim limitation as evidenced by Haptic's infringement contentions, Li-iFixit's interactive zone also overlays the mounting surface outside a perimeter of the housing. APPLE-1101, 16-17, 50-51. Li-iFixit's interactive zone spans the back side of the iPhone and, as alleged by Haptic, overlays the mounting surface. APPLE-1008, [0021], [0030]. Because the back side of the iPhone where the interactive zone is located is larger than the size of the logic board (housing), the interactive zone extends beyond the perimeter of said housing. *Id.* iFixit shows that the accelerometer positioned on the logic board has a small size (and thus a small perimeter) compared to the full back cover of the iPhone. APPLE-1011, 6-7, 9-10. The annotated iFixit image below shows how the interactive zone extends outside a perimeter of said housing, consistent with Haptic's infringement contentions.





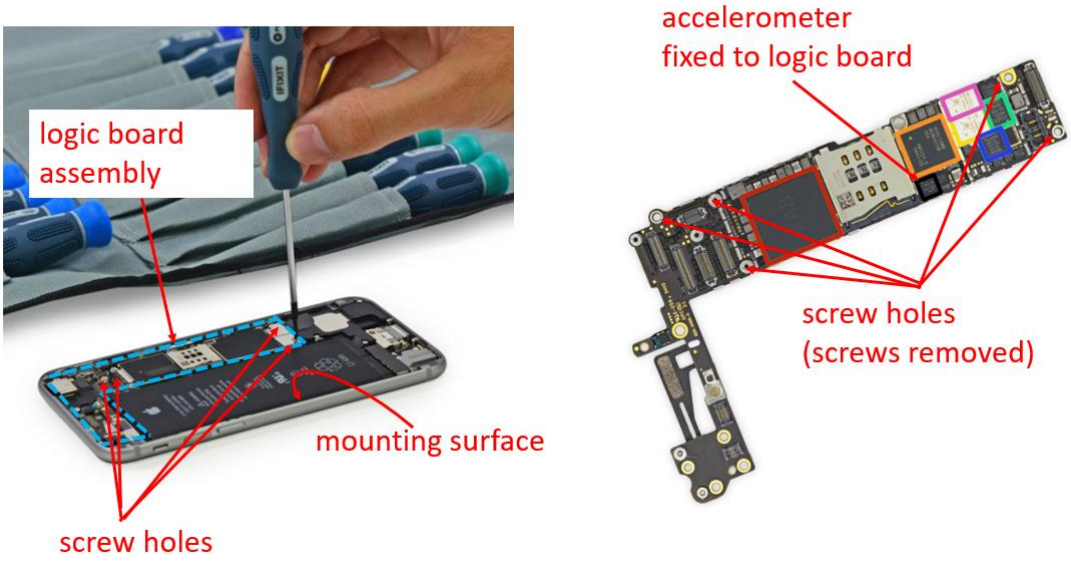
Left: APPLE-1011, 5 (modified and annotated)

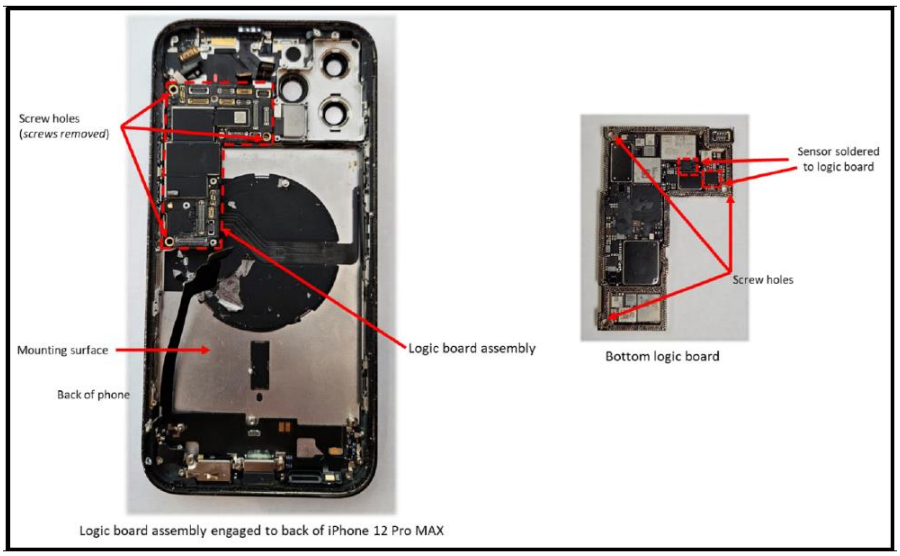
Right: APPLE-1101, 17 (image from Haptic's infringement contentions)

[1b-v] said sensor being in a fixed position relative to said engagement means,

361. Li-iFixit's sensor (InvenSense MP67B 6-axis Gyroscope and Accelerometer Combo) is in a fixed position (attached to the logic board) relative to the engagement means. APPLE-1011, 6-7; APPLE-1101, 17-18, 51-52. A POSITA would have understood that an accelerometer would be attached to a logic board by a method such as adhesive or soldering, and that the logic board would further be firmly attached within the body of the iPhone so that the components (accelerometer and logic board) are not loose within the phone body. A POSITA would have understood that holding the components fixed within the phone body allows the accelerometer to function appropriately (*see supra* §VI.B.3) and prevents damage to the components.

362. As shown below, the engagement means includes an attachment means (screws and screw holes, *see* [1a] and [1e]) and a transmission portion (a portion of the logic board, *see* [1a] and [1e]). APPLE-1011, 4, 6-7, 9-10; APPLE-1008, Fig. 15; §§IX.D.4.[1a], [1e]. In Li-iFixit, the sensor (accelerometer) is attached to the housing (logic board assembly). APPLE-1011, 4, 6-7, 9-10; APPLE-1008, Fig. 15. Because the sensor is fixed in place on the housing (i.e., the accelerometer is soldered to the logic board) and the engagement means is also fixed with regard to the housing, the sensor (accelerometer) is in a fixed position relative to the engagement means. APPLE-1011, 4, 6-7, 9-10; APPLE-1008, [0035]. The accelerometer cannot (under normal circumstances) be moved on the logic board or relative to the screws that hold the logic board in place, and thus the sensor is held in a fixed position relative to the engagement means, comprising attachment means (screws) and a transmission portion (logic board), under Haptic's construction and apparent understanding based on their infringement contentions. *Supra* §VIII.





Top: APPLE-1011, 4, 6-7 (annotated)

Bottom: APPLE-1101, 18 (image from Haptic's infringement contentions)

[1b-vi] wherein a contact interaction associated with said mounting surface within said interactive zone is detected by said sensor as data signals,

363. Regardless of the exact bounds of the limitation [1b-vi], Li-iFixit renders obvious at least the '738 patent's preferred embodiment. The '738 patent

states that "[w]hen the sensor is an accelerometer, the data signals are vibration data, such as amplitude, intensity, and duration." *Id.*, 5:11-13. The '738 patent also states that "[t]he contact interaction 60 is detected as data signals 70 by the sensor 30 [and t]he data signals 70 are sent from the sensor 30 to the server 30 [to] determine[] a data pattern 80 corresponding to the data signals 70 of the contact interaction 60." APPLE-1001, 10:57-68, *see also* 4:65-66 ("The contact interaction generates the data signals of the sensor through the transmission portion of the housing"), Fig. 2.

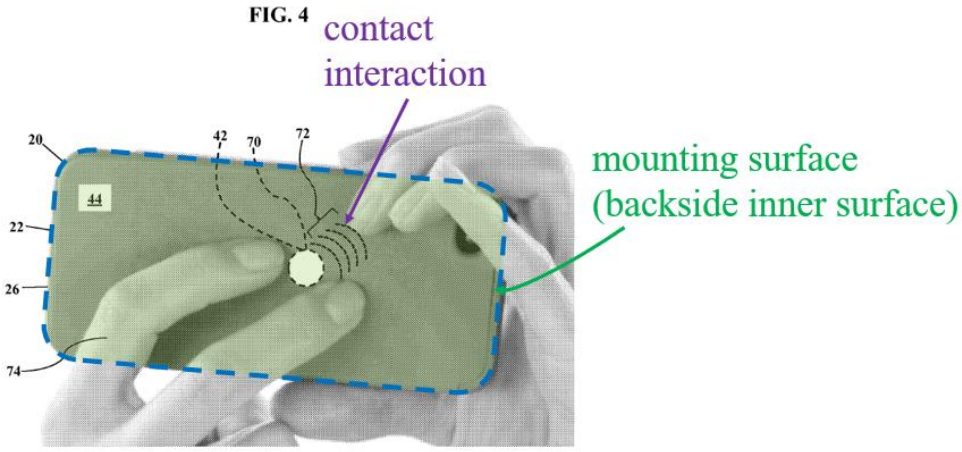
364. Like the '738 patent, Li-iFixit's contact interaction (e.g., a tap on the back of the phone) is detected by the sensor (accelerometer) as data signals. (gesture detector senses vibration from any mechanical and/or acoustic wave). APPLE-1008, [0024] ("the gesture detector 42 may sense the vibration 72 due to both mechanical waves and acoustic waves"), [0030], [0022], [0023], [0026], [0031]. Li describes that "the gesture detector 42 may sense the vibration 72 due to both mechanical waves and acoustic waves." APPLE-1008, [0024]. Accordingly, in Li-iFixit, the user's gesture on the backside of the phone (contact interaction associated with the mounting surface) is detected as vibration signals associated with mechanical and acoustic waves – just as in the '738 patent, and indeed, just as a POSITA would expect.

365. Li describes, "[a]s the gesture is drawn [on the supplemental gesture surface area 92 formed on the outer surface 44 of the backside 40 of the electronic device] the vibration 72 propagates through the body 26 as mechanical and/or acoustical waves [and the] ***gesture detector 42 senses the vibration 72***." APPLE-1008, [0030] (emphasis added). Accordingly, in Li-iFixit, when a user performs a gesture on the backside of the phone (contact interaction associated with the mounting surface) it is within the interactive zone of the supplemental gesture area in which the accelerometer can detect its vibrations. Because, under Haptic's apparent understanding of the claim limitation as evidenced by the infringement contentions, the mounting surface is within the interactive zone of the back of the iPhone, the contact interaction on the back of the iPhone impacts the mounting surface and is associated with the mounting surface within the interactive zone. APPLE-1101, 18-19, 53-54; APPLE-1008, [0030], [0037].

[1b-vii] said contact interaction being comprised of an impact on said mounting surface,

366. Li-iFixit's contact interaction (e.g., a tap on the back of the iPhone) comprises an impact on the mounting surface (e.g., the part of the iPhone that engages with the housing), consistent with Haptic's understanding of the claim element as evidenced by the infringement contentions and briefing in the co-pending District Court litigation. APPLE-1101, 12, 46; APPLE-1008, [0022], [0023], Fig. 4. For example, Li's Figure 4, illustrates a user tapping on the

backside of the phone. APPLE-1008, Fig. 4. Under Haptic's understanding of the claim language, Li-iFixit's disclosure of tapping on the back of the phone satisfies "said contact interaction being comprised of an impact on said mounting surface."



APPLE-1008, Fig. 4 (annotated)

367. For example, in Haptic's briefing in opposition to Apple's Rule 12(b)(6) Motion in the co-pending N.D. Cal. litigation, Haptic explained its construction of this term, stating "a person of ordinary skill in the art would understand an impact on a surface to include both impacts originating on the surface and impacts originating elsewhere that have an impact on the surface." APPLE-1104, 9. Because Li-iFixit similarly describes a user tapping or drawing a gesture on the backside of the iPhone opposite the mounting surface located on the inside back panel of the iPhone, Li-iFixit provides this limitation under Haptic's apparent understanding of the term because the user's tapping or gesture is an

"impact[] originating elsewhere that [has] an impact on the surface." *Id.*; APPLE-1008, [0022], [0023], Fig. 4.

[1b-viii] said data signals being comprised of vibration data of said contact interaction;

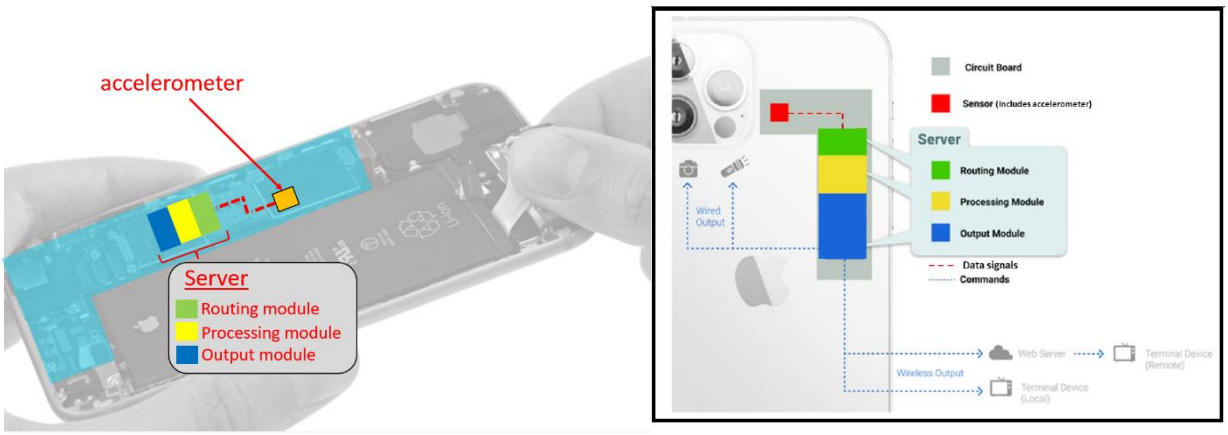
368. As described above, Li-iFixit's accelerometer detects data signals (vibration) that comprise vibration data (mechanical waves) of the contact interaction. APPLE-1008, [0026] ("the gesture detector 42 may sense mechanical waves"); *see also* APPLE-1008, [0011], [0024], [0030], [0037], Fig. 17. This is consistent with what a POSITA would expect from an accelerometer, which detects vibrations.

[1c-i] a server in communication with said sensor,

369. Li-iFixit includes a server (combination of a routing module, a processing module, and an output module; *see infra* §§IX.D.4.[1c-iii]-[1c-vi] (Ground 2A)) in communication (via the logic board circuitry) with the sensor, consistent with Haptic's interpretation of the claimed server as evidenced by the infringement contentions. APPLE-1101, 20-21, 54-55; APPLE-1008, [0022], Fig. 3. As illustrated below in the figure from Haptic's infringement contentions, Haptic treats the server as the grouping of the various modules that make up the server in the claim. APPLE-1101, 20-21, 54-55. As I describe below, Li-iFixit includes each of the claimed modules consistent with Haptic's apparent understanding of the module terms as evidenced by the infringement contentions,

and accordingly also includes a server under the same understanding. APPLE-1101, 20-21, 54-55.

370. Li describes that "[w]hen the user draws and/or taps a gesture on the outer surface of the body… the [sensor] generates an output signal 52 [and] [t]he processor 30 [of the server] receives the output signal 52." APPLE-1008, [0022]; *see also id.*, [0023]. A POSITA would have understood from Li's disclosure that the server (including a processing module, routing module, and output module) of Li-iFixit is in communication with the accelerometer, as illustrated below.



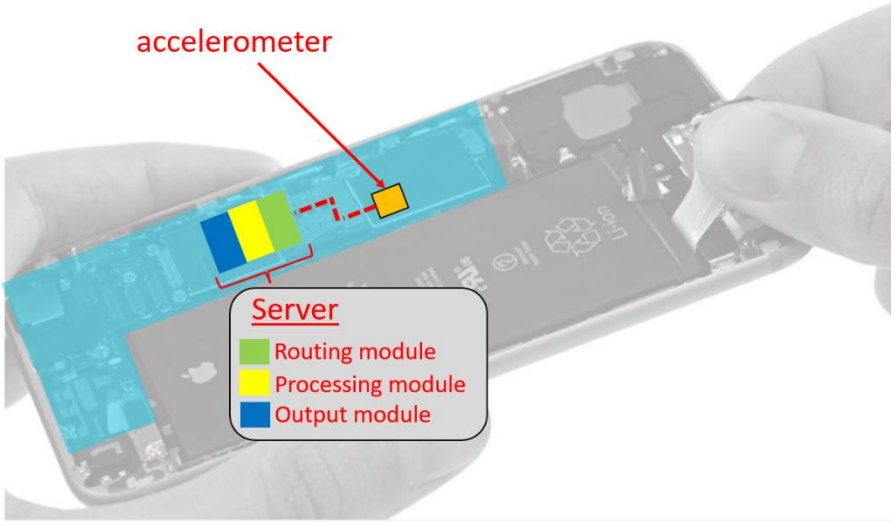
Left: APPLE-1011, 5 (modified and annotated)

Right: APPLE-1101, 21 (image from Haptic's infringement contentions)

[1c-ii] said server being comprised of a routing module,

371. Li-iFixit's server includes a routing module (at least the circuitry that forms the path from the sensor to the processing module, as well as any intermediate registers, level translators, connectors, interfaces, or logic for connecting the sensor to the processing module; the routing module includes the

outbound connections from the sensor to the processing module), consistent with Haptic's understanding of the claim element as evidenced by infringement contentions (see Fig. 5, below). APPLE-1011, 6-7; APPLE-1101, 21-23, 55-56. Li-iFixit's routing module is discussed further below in Element [1c-v]. §IX.D.4.[1c-v] (Ground 2A).

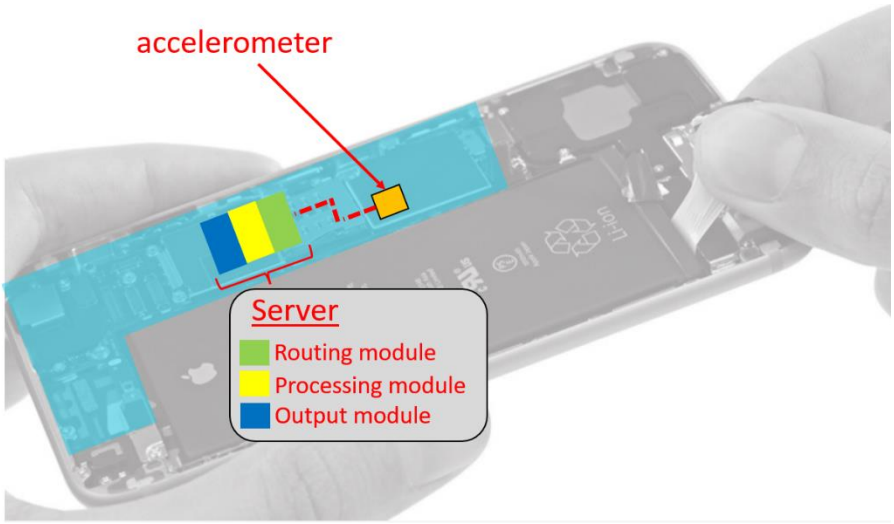


APPLE-1011, 5 (modified and annotated)

[1c-iii] a processing module being connected to said routing module, and

372. Li-iFixit includes a processing module (e.g., including the functionality of Li's processor 30) connected (via the logic board circuitry) to the routing module, consistent with Haptic's understanding of the claim element as evidenced by infringement contentions (see Fig. 5, below). APPLE-1101, 23-24, 56-57; APPLE-1011, 6-7; APPLE-1008, [0022], [0038]-[0039], Fig. 3, Fig. 15. A POSITA would have understood that Li-iFixit's processing module is connected to the routing module because the processing module receives data from the

accelerometer for processing. A POSITA would have understood that the circuitry that receives the accelerometer data (the routing module) would need to transmit the data to the processing module in order for the processing module to process the data, and thus that the processing module would be connected to the routing module. Li-iFixit's processing module is discussed further below in Element [1c-vi]. §IX.D.4.[1c-vi] (Ground 2A).

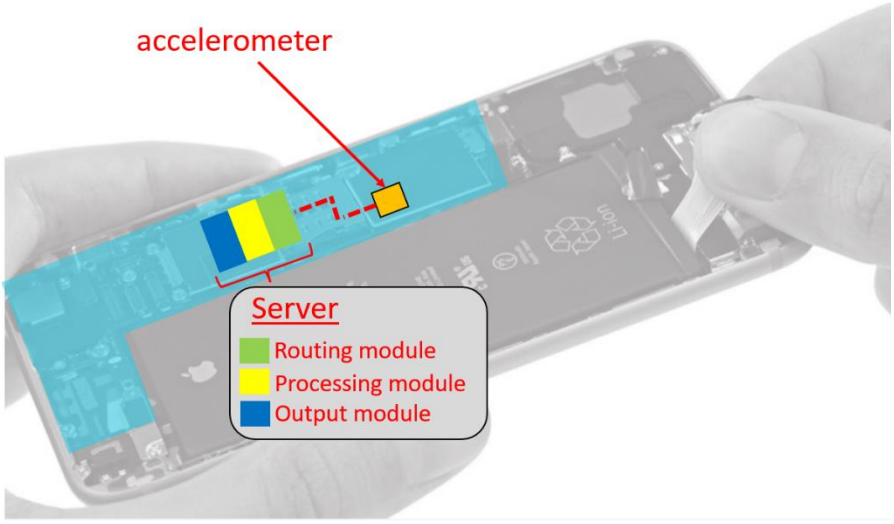


APPLE-1011, 5 (modified and annotated)

[1c-iv] an output module connected to said processing module,

373. Li-iFixit includes an output module ("the circuitry that forms the path from the processing module to the receiving module in a terminal device" (*see infra* §IX.D.4.[1d-i] (Ground 2A)), "as well as any intermediate registers, interfaces, level translators, connectors, interfaces, or logic for connecting the processing module to the receiving module in a terminal device") connected to the processing module, consistent with Haptic's understanding of the claim element as

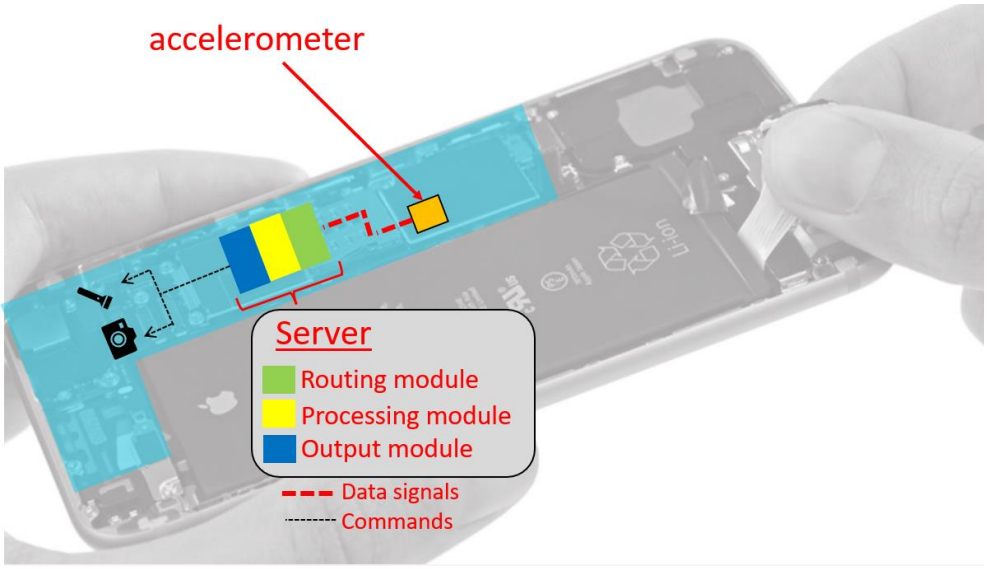
evidenced by infringement contentions (see Fig. 5, below). APPLE-1101, 24-25, 57-58; APPLE-1011, 6-7; APPLE-1008, [0020], [0022]. A POSITA would have understood that Li-iFixit's output module is connected to the processing module because the processing module determines a command that is transmitted to control a function of the electronic device. APPLE-1008, [0020], [0022]. A POSITA would have understood that after the processing module determines an appropriate command associated with the user gesture, the command is transmitted to the application or component to be performed. A POSITA would have recognized that an output module performs this function. Li-iFixit's output module is discussed further below in Element [1d-v]. §IX.D.4.[1d-v] (Ground 2A).



APPLE-1011, 5 (modified and annotated)

[1c-v] said routing module receiving said data signals from said sensor,

374. Li-iFixit's routing module—circuitry that forms the path from the sensor to the processing module—receives the data signals from the sensor before routing the signals to the processing module, consistent with Haptic's understanding of the claim element as evidenced by infringement contentions. §IX.D.4.[1c-ii] (Ground 2A); APPLE-1008, [0022], [0020], [0023], Figs. 3, 15; APPLE-1011, 6-10. In Li-iFixit, "[t]he processor receives the output signal 52" from the sensor. APPLE-1008, [0022]. A POSITA would have understood that the processor receives the signal from the sensor via a routing module – that is via circuitry that forms the path between the sensor and the processor. The routing module receives the data signals from the sensor, and the processing module receives the data signals from the routing module. APPLE-1008, [0020], [0022], Figs. 3, 15; APPLE-1011, 6-10; APPLE-1101, 25-27, 58-60. Accordingly, Li-iFixit renders obvious a routing module receiving the data signals from the sensor, consistent with Haptic's understanding of the claim element as evidenced by infringement contentions.



APPLE-1011, 5 (modified and annotated)

[1c-vi] said processing module determining a data pattern corresponding to said data signals of said contact interaction and matching said data pattern with a gesture profile, said gesture profile being associated with a command; and

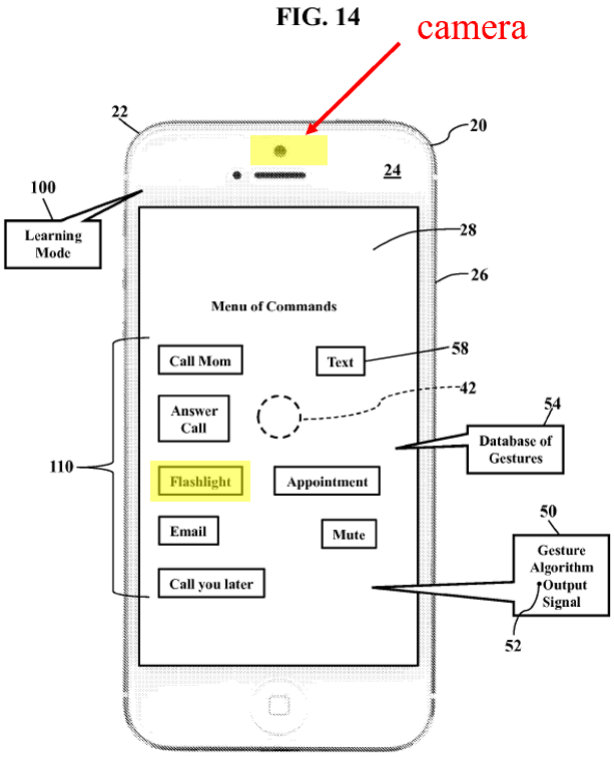
375. Li-iFixit's processing module (processor 30) determines (using a gesture algorithm) a data pattern (discrete data points of the output signal 52) corresponding to said data signals of said contact interaction and matches the data pattern with a gesture profile (command entries stored in a database), consistent with Haptic's understanding of the claim element as evidenced by infringement contentions. APPLE-1101, 25-27, 58-61. The gesture algorithm includes "instructions, code, and/or programs that cause the processor 30 to interpret any gesture input sensed by the gesture detector 42." §IX.D.4.[1c-iii] (Ground 2A); APPLE-1008, [0022], [0038], [0039], Figs. 3, 18.

376. A POSITA would have understood Li's description of the interpretation of the gesture input to mean the identification of a data pattern representative of the vibration data signals in order to determine which gesture the user performed on the back of the phone for matching the gesture to an intended instruction to control the phone. Li describes that the processor matches the data pattern to a stored gesture (gesture profile) associated with a command by "compar[ing] the output signal 52 to the entries stored in the database 54 of gestures … [and] retriev[ing] the corresponding command 58." APPLE-1008, [0022]; *see also id*., [0032] ("[g]estures may be predefined to invoke or call commands, functions, or any other action"). Accordingly, consistent with Haptic's understanding of the claim element as evidenced by infringement contentions, the processing module determines whether the data signals represent a data pattern that corresponds to a matching gesture profile (for example, a tap profile). §VIII (Claim Construction); APPLE-1101, 25-27, 58-61.

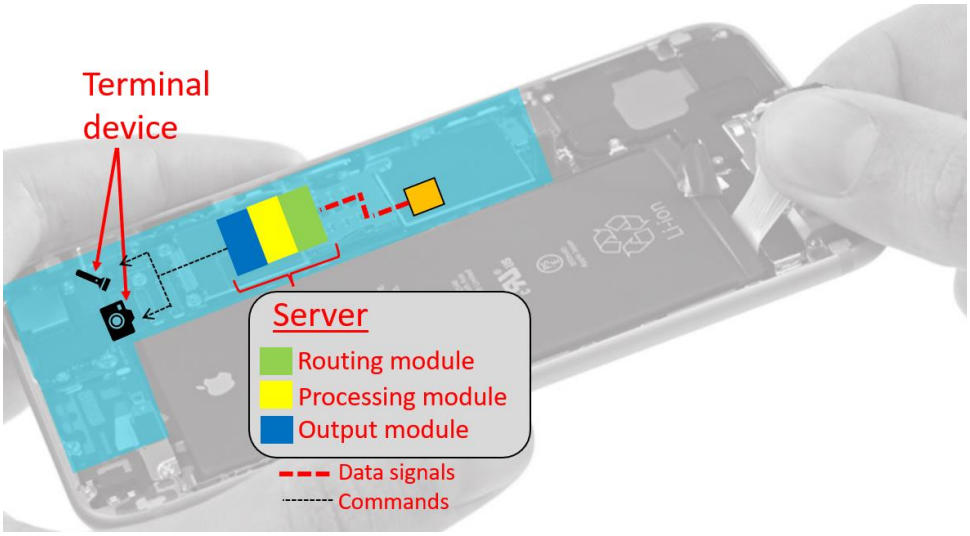
[1d-i] a terminal device

377. Applying Haptic's apparent understanding of "terminal device" based on the Joint Claim Construction statement and infringement contentions, Li-iFixit includes a terminal device (e.g., the iPhone's camera or flashlight). §VIII (Claim Construction); APPLE-1101, 29-31, 61-64; APPLE-1008, [0020], Fig. 14. Li describes that gestures can be used to control the phone's flashlight (see APPLE-

1008, 14, below) or "to execute a command, such as transitioning to a different display screen, answering a call, capturing a photo, or any other action." APPLE-1008, [0020]. In Haptic's infringement contentions, Haptic identifies "the iPhone's camera [and] flashlight" as examples of terminal devices. APPLE-1101, 29. Accordingly, Li-iFixit render obvious a terminal device, consistent with Haptic's understanding of the term as evidenced by the infringement contentions.



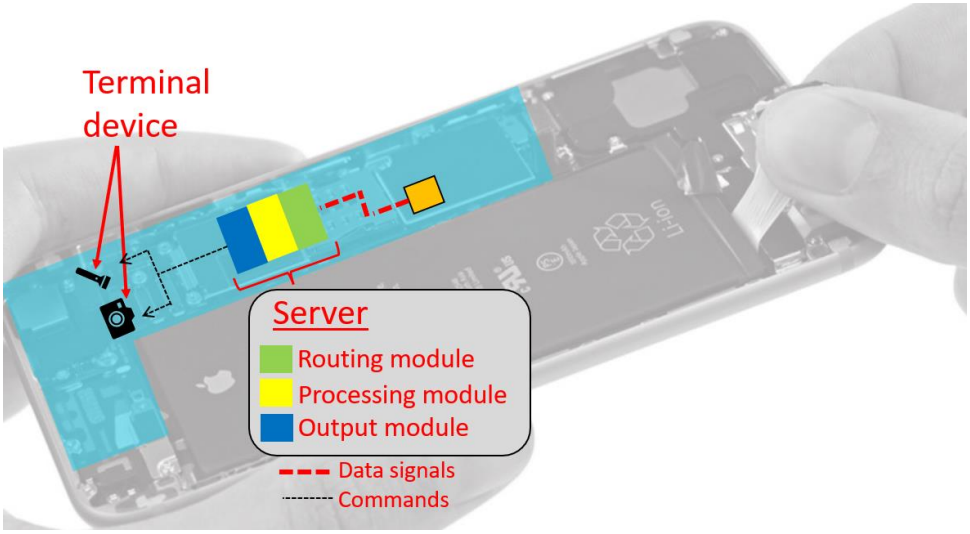
APPLE-1008, Fig. 14 (annotated)



APPLE-1011, 5 (modified and annotated)

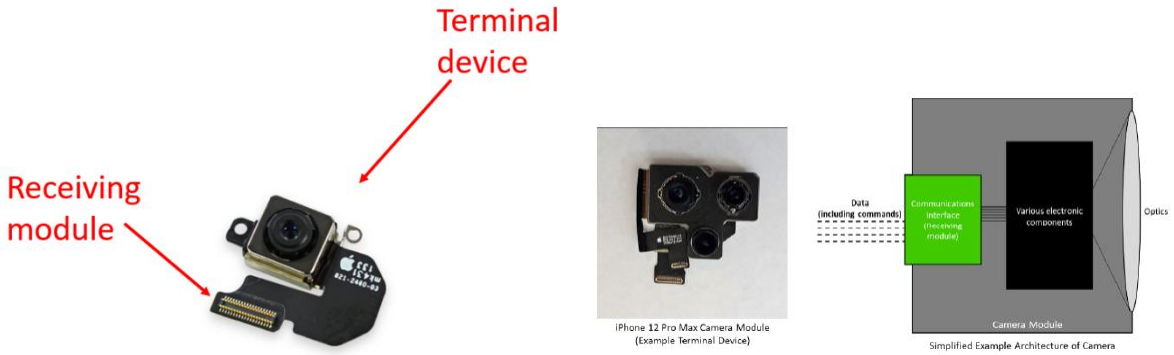
[1d-ii] being comprised of a receiving module

378. Each Li-iFixit terminal device comprises a receiving module (associated integrated electronics for receiving a command from the output module), consistent with Haptic's infringement contentions. §VIII (Claim Construction); APPLE-1101, 29-31, 61-64; APPLE-1008, [0020]-[0022], Fig. 14; APPLE-1011, 6-7, 9-10.



APPLE-1011, 5 (modified and annotated)

379. For example, the Li-iFixit rear-facing camera ("terminal device") includes a dedicated receiving module for wired connection to the output module and integrated electronics for receiving a command from the output module. APPLE-1011, 5-7. Li-iFixit's front-facing camera also includes a dedicated receiving module. *See id.*, 4. As illustrated by the side-by-side figures below, the camera, per iFixit, includes a receiving module consistent with Haptic's infringement contentions.



Right: APPLE-1011, 6 (annotated)

Left: APPLE-1101, 29 (image from Haptic's infringement contentions)

380. Additionally, iFixit illustrates that the lens used as a flashlight on the iPhone is located next to the camera. APPLE-1011, 2 (showing flashlight lens next to camera lens on back of phone). iFixit further describes that the rear-facing camera includes "True Tone flash." *Id.*, 6. Accordingly, the flashlight also

includes a receiving module, consistent with Haptic's apparent understanding of the claim term as evidenced by the infringement contentions.

[1d-iii] and means for initiating activity of said terminal device corresponding to said command,

381. Under Haptic's construction, the "means for initiating activity" is a §112(f) term that has the function of initiating activity of the terminal device corresponding to the command, and has a corresponding structure of a "switch or other actuating mechanism that changes the status of a terminal device" and equivalents thereof. §VIII (Claim Construction); APPLE-1001, 5:53-55; APPLE-1107, 2; *see also* APPLE-1101, 31-33, 64-66. Applying Haptic's construction, Li-iFixit necessarily includes means for initiating activity of the terminal device corresponding to the command (switches, transistors, physical actuators, other actuating mechanisms, and equivalents thereof) for changing the status of each terminal device. APPLE-1101, 31-33, 64-66; APPLE-1008, [0020], [0022], Fig. 14.

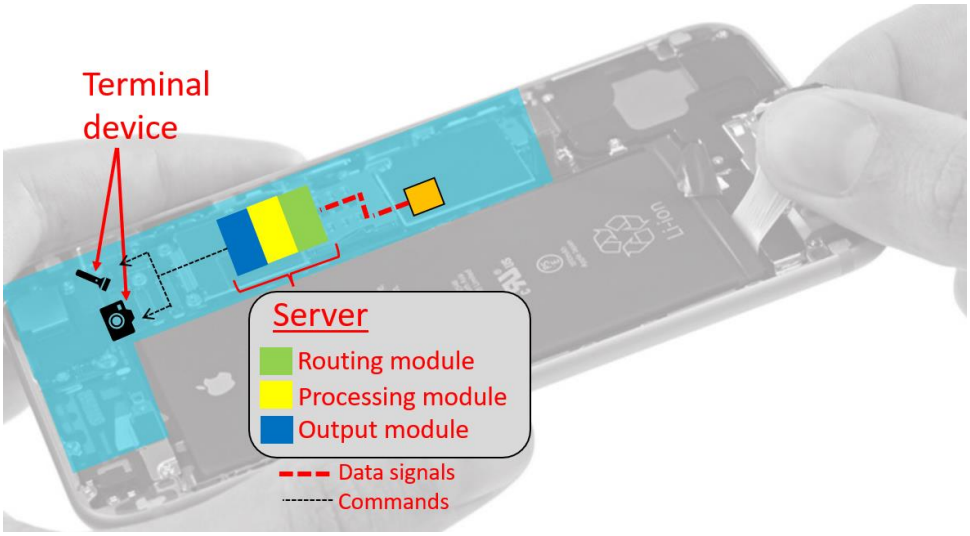
382. Li describes actions of the iPhone's applications and components in response to the user gestures matched to commands. APPLE-1008, [0020], [0022]. A POSITA would have understood that, without mechanisms to allow Li's applications and components to perform their associated actions, Li's components would be unable to function in response to commands. A POSITA would have further understood that a terminal device that executes a status change in response

to execution of a command would include actuators that operate the terminal device and switches the device between statuses. Accordingly, Li-iFixit must include switches, transistors, physical actuators, other actuating mechanisms, and equivalents thereof that initiate activity of said terminal device corresponding to said command. APPLE-1008, [0020] ("such as transitioning to a different display screen, answering a call, capturing a photo, or any other action"), [0023].

[1d-iv] said terminal device being in communication with said server,

383. Under Haptic's apparent understanding of this claim limitaion as evidenced by Haptic's infringement contentions, each of Li-iFixit's terminal devices is in communication with the server because each terminal device is controlled by the processor (i.e., part of the server) executing the command. APPLE-1101, 31-33, 64-66; APPLE-1008, [0020], [0022].

384. For example, Li describes that "[t]he processor 30 interprets the swiping motion to execute some command, such as transitioning to a different display screen, answering a call, capturing a photo, or any other action." APPLE-1008, [0020]. Li's disclosure of the processor (part of the server) executing a command for a component to change status implies that the processor, and thus the server, is in communication with the terminal device in order to execute the command. *Id.*; *see also* [0022] ("The processor 30 then executes the command 58 in response to the output signal 52").

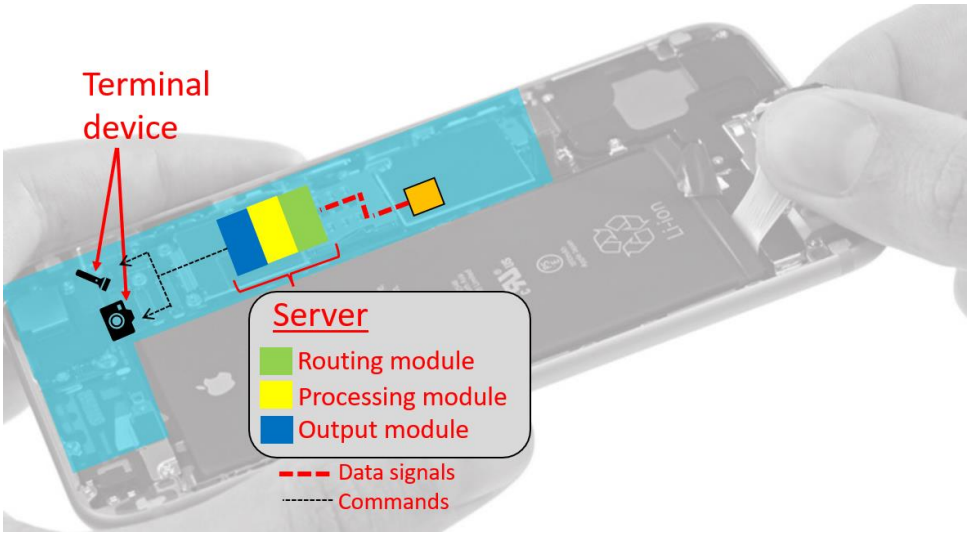


APPLE-1011, 5 (modified and annotated)

[1d-v] said output module transmitting said command to said receiving module,

385. Li-iFixit's output module (i.e., circuitry that forms the path from the processing module to the receiving module in the terminal device) transmits the command from the processing module to the receiving module, consistent with Haptic's apparent understanding of the claim term as evidenced by the infringement contentions. §IX.D.4.[1c-iv] (Ground 2A); APPLE-1008, [0020], [0022]; APPLE-1101, 31-33, 64-66. As described above, the server is in communication with the terminal device, because Li's processor executes a command at the component or application (terminal device). *Supra* §IX.D.4.[1d-iv] (Ground 2A). A POSITA would have understood that Li's disclosure that the processor "executes the corresponding command 58" means that the instructions associated with the command 58 are transmitted from the server's output module to the terminal device (e.g., the phone's flashlight or camera) and received by the

terminal device at a dedicated receiving module for wired connection (see §IX.D.4.[1d-ii] (Ground 2A)).



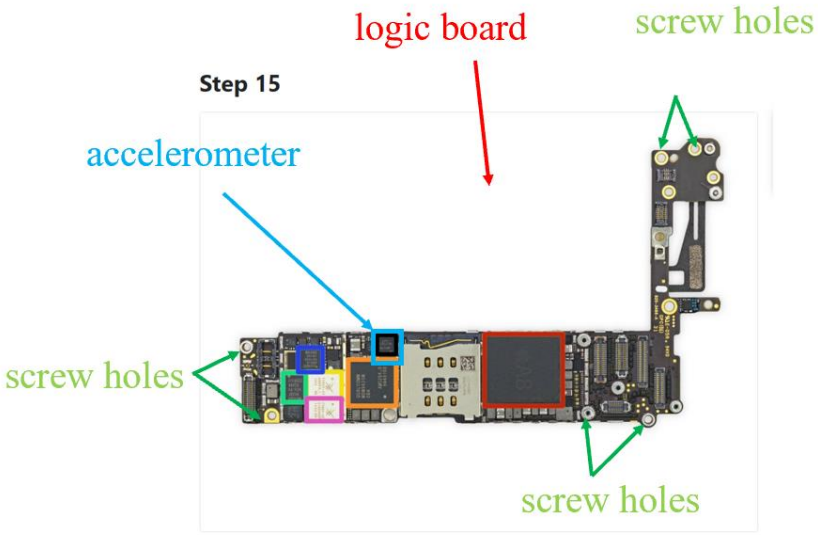
APPLE-1011, 5 (modified and annotated)

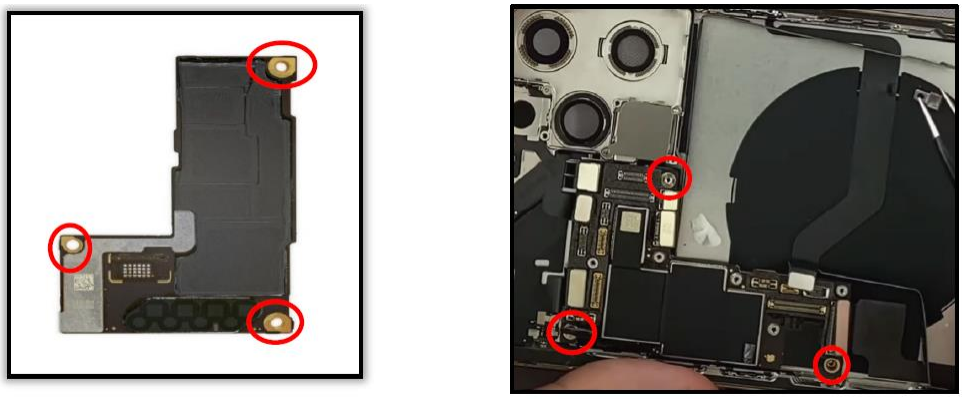
[1e] wherein said engagement means of said housing comprises: an attachment means between said housing to said mounting surface; and a transmission portion connecting said sensor to said attachment means of said housing and being comprised of a material with flexibility different than said mounting surface so as to set a rigid position of said sensor relative to said mounting surface, said contact interaction generating said data signals of said sensor through said transmission portion.

386. Under Haptic's construction, the "engagement means" term (included in part of [1a] and [1e]) is treated under §112(f) as a means-plus-function term the functions of engagement, attachment or holding the housing to the mounting surface, and connecting the sensor to the mounting surface. §VIII (Claim Construction); APPLE-1107, 8-10. Under Haptic's construction, the corresponding structure is an "attachment means" and a "transmission portion;" adhesive, mechanical fasteners, threaded screws, screw holes, or other components

to hold the housing to the mounting surface; and a portion connecting the sensor to the housing, which can be comprised of frames, brackets, a spring loaded portion, or a material with flexibility different than the materials of the mounting surface or surface of the contact interaction; and equivalents thereof. APPLE-1107, 8-10. Based on Haptic's infringement contentions, Haptic's understanding of the claimed engagement means is broad enough to include threaded screws and screw holes in a logic board assembly and a portion of a logic board that connects a sensor to the "attachment means." APPLE-1101, 9-12, 33-35, 43-45, 67-68.

387. Consistent with Haptic's understanding of the term as evidenced by the infringement contentions, Li-iFixit includes screws and screw holes formed in a logic board assembly and a logic board assembly that extends from the InvenSense MP67B 6-axis Gyroscope and Accelerometer Combo (sensor) to the screws and screw holes. APPLE-1008, [0027], [0033]-[0035], Fig. 15; APPLE-1011, 3-4, 6-7, 9-10.



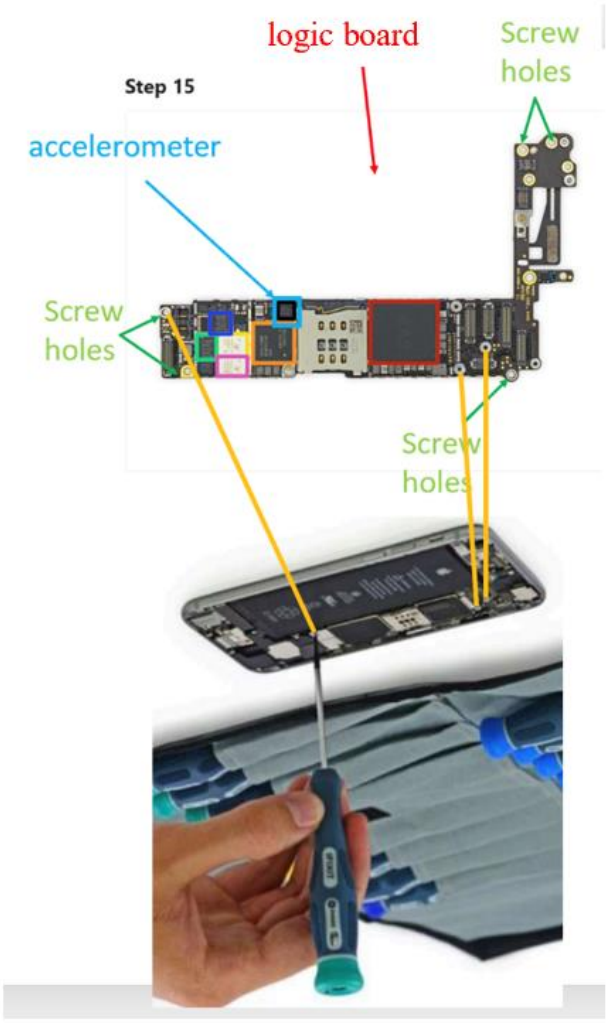


Top: APPLE-1011, 6-7 (step 15, annotated)

Bottom: APPLE-1101, 34

388. First, regarding the "attachment means," Li-iFixit provides threaded screws and screw holes through the logic board assembly for attaching the logic board assembly to the back cover of the iPhone, consistent with Haptic's infringement contentions. APPLE-1101, 12, 46. Li's Figure 15 depicting an exploded view of an example iPhone illustrates dotted lines showing where screws are used to connect the components and structures to one another. APPLE-1008,

Fig. 15. Additionally, iFixit explains that the internal structures of the iPhone are held in place by screws. APPLE-1011, 4 ("there are certainly Phillips screws on the inside [of the iPhone]"), 6-7 (showing logic board with holes for screws).



APPLE-1011, 4, 6-7 (combined and annotated to show the position of the screws and screw holes)

389. As illustrated above, iFixit depicts that screws are removed before the logic board can be removed from the back cover of the iPhone. APPLE-1011, 4.

For example, the screws shown being removed in the photo on iFixit's page 4 line up with the screw holes in the logic board shown in the photo on iFixit's page 6-7. APPLE-1011, 4, 6-7. Accordingly, the screws through the logic board are attachment means that attach the logic board (housing) to the back cover of the phone (mounting surface), consistent with Haptic's construction and apparent understanding as evidenced by their infringement contentions. APPLE-1101, 9-12, 43-46.

390. Second, Li-iFixit also provides that the accelerometer is positioned on the logic board and that the logic board connects the accelerometer to the screws that hold the logic board in place (i.e., "transmission portion") within the phone and relative to the back cover of the phone,"), consistent with Haptic's construction and apparent understanding as evidenced by their infringement contentions. APPLE-1011, 5, 6-7, 9-10; APPLE-1101, 9-12, 43-46. In Li-iFixit, the sensor (accelerometer; see §§IX.D.4[1b-i] and [1b-iii] (Ground 2A)) is connected to the attachment means (screws and screw holes) via a portion of the logic board, such that when the user taps on the back of the iPhone, a vibration is created and transmitted through the logic board (transmission portion) to the sensor. APPLE-1008, Fig. 15; *see also* §VI.B.3 (describing how accelerometers work). Li-iFixit's screws, screw holes and logic board assembly collectively

perform the functions of attaching the housing to the mounting surface and connecting the sensor to attachment means of said housing.

Transmission portion …being comprised of a material with flexibility different than said mounting surface

391. Further, under Haptic's apparent understanding of the claim element as evidenced by the infringement contentions, Li-iFixit's transmission portion (part of the logic board) comprises a material (e.g., a glass epoxy composite, such as FR-4) with a flexibility different that the mounting surface (the back of the iPhone, which is made of aluminum). APPLE-1101, 9-12, 33-35, 43-45, 67-68. Li describes that "the body 26 [of the smartphone] is constructed of aluminum, magnesium, stainless steel, or any other metal." APPLE-1008, [0037], [0035], [0023]. A POSITA would have understood that the iPhone casing in the Li-iFixit combination is formed from aluminum; for example, MacRumors published that "7000 Series aluminum [was used] for the iPhone 6s… to improve the strength and durability" of the iPhone. APPLE-1034, 1. A POSITA would have understood that aluminum and glass epoxy are different materials that would have different flexibilities. Indeed, according to Haptic, a glass epoxy composite, such as FR-4, typically has a Young's modulus in the range of 0.6 to 2.6 GPa whereas aluminum has a Young's modulus values of approximately 68 GPa. APPLE-1101, 35-36, 68-69.

392. Furthermore, a POSITA would have recognized that the printed circuit board has a different flexibility than the back cover of the iPhone due to the different material composition, thickness, design, and intended use of each component. APPLE-1011, 6-7, 9-10. A POSITA would have understood that an aluminum case for an iPhone provides protection for the internal components (including allowing flexing and absorption of impacts from drops and the like), while a glass epoxy logic board provides a rigid substrate for electronic modules. A POSITA would have appreciated that the purpose of the casing differs from the purpose of the logic board and would have understood that the material properties of each would be different.

Setting a rigid position of said sensor relative to said mounting surface

393. Under Haptic's construction and apparent understanding of the claim element, the transmission portion (part of the logic board) also sets a rigid position of the sensor (accelerometer) relative to the mounting surface (back of the iPhone). APPLE-1101, 36-37, 69-70; APPLE-1011, 6-7, 9-10; APPLE-1008, [0035], [0023]. As described above, the sensor is in a fixed position relative to the engagement means. *Supra* §IX.D.4.[1b-v] (Ground 2A). As also described above, fixing the accelerometer enables the accelerometer to accurately sense vibrations without attenuation of the transmitted vibration pulses. *Supra* §VI.B.3.

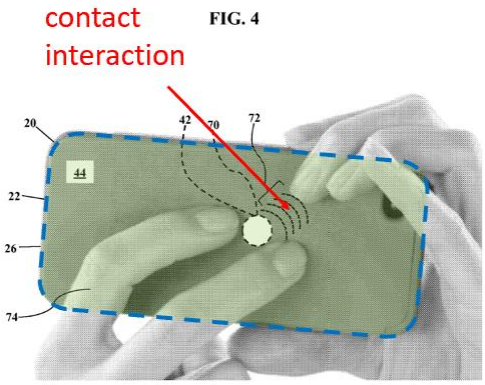
394. In Li-iFixit, the accelerometer is soldered to the logic board, which is rigid (i.e., formed from glass epoxy as described above), and the logic board is attached to the inside back cover of the iPhone (mounting surface) by the screws and screw holes. APPLE-1008, [0035]; APPLE-1011, 4, 6-7, 9-10. In normal circumstances, the accelerometer does not move about on the logic board, and the logic board is not loose within the body of the iPhone. The accelerometer position is thus rigid with respect to the mounting surface, consistent with Haptic's apparent understanding of the claim term as evidenced by the infringement contentions. APPLE-1101, 35-36, 68-69.

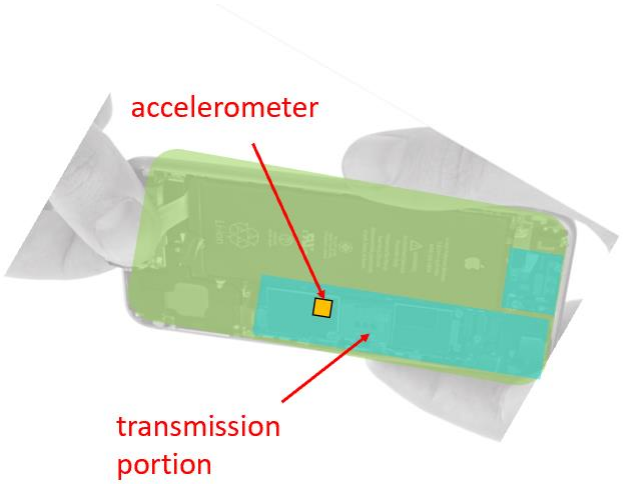
Said contact interaction generating said data signals of said sensor through said transmission portion

395. Regardless of the exact bounds of the limitation "said contact interaction generating said data signals of said sensor through said transmission portion," Li-iFixit includes at least the '738 patent's preferred embodiment. The '738 patent states that "[t]he contact interaction 60 is detected as data signals 70 by the sensor 30…." APPLE-1001, 10:57-59, Fig. 2. Like the '738 patent, Li-iFixit's contact interaction (e.g., a tap on the back of the phone) is detected as data signals (output signal 52 generated in response to any mechanical and/or acoustic wave) by the sensor (accelerometer). *Supra* §§IX.D.4.[1a] and [1b-vi]; APPLE-1008, [0022] ("[w]hen the user … taps a gesture on the outer surface of the body… the

gesture detector 42 generates an output signal 52"), [0023], [0024], [0026], [0031], [0030].

396. Under Haptic's apparent understanding, Li-iFixit's contact interaction (taps on the back of the phone) generates the data signals (output signals) of the sensor (accelerometer) through the transmission portion (part of the logic board). *See* §§IX.D.4.[1b-i], [1b-iii], and [1b-vi]-[1b-viii]. In Li-iFixit, when the user taps on the back of the phone, a vibration is created and transmitted through the logic board to the sensor. APPLE-1008, [0023], Figs. 4, 15; APPLE-1011, 6-7, 9-10. This is consistent with what a POSITA would have understood occurs in a device that contains an accelerometer for measuring vibrations: "[t]he shock of the tap is transmitted through the body of the device to the accelerometer when tapping occurs." APPLE-1009, [0011].





Left: APPLE-1008, Fig. 4 (annotated)

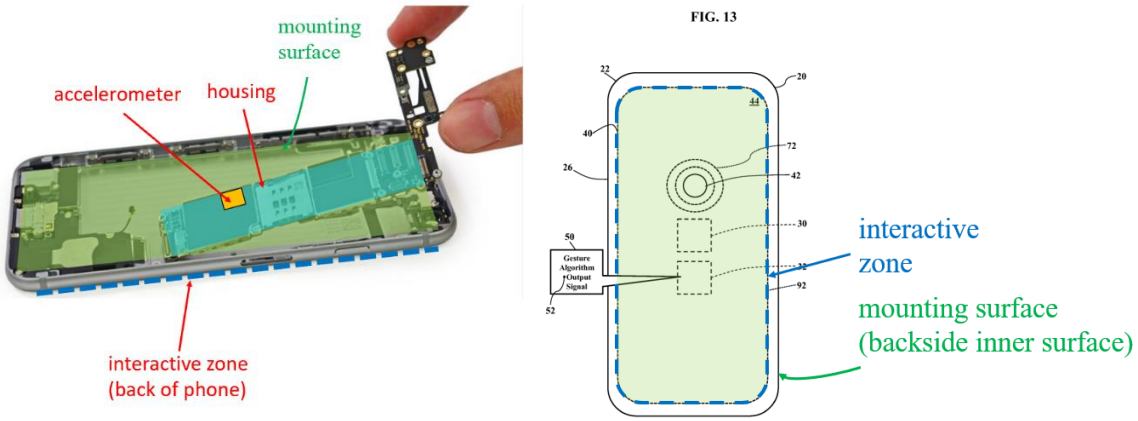
Right: APPLE-1011, 5 (step 11) (annotated and modified)

397. Accordingly, under Haptic's construction of "engagement means" and apparent understanding of the term as evidenced by Haptic's infringement contentions, Li-iFixit includes screws and screw holes (attachment means) and a portion of a logic board assembly (transmission portion) that attach the logic board portion (housing) that includes the accelerometer (sensor) to the inside back cover of the iPhone (mounting surface), connect the accelerometer (sensor) to the screws and screw holes (attachment means), set a rigid position of the accelerometer (sensor) relative to the inside back cover of the iPhone (mounting surface), and transmit data signals from the screws and screw holes (attachment means) to the accelerometer (sensor). §VIII (Claim Construction); APPLE-1101, 9-12, 33-35, 43-45, 66-68; APPLE-1011, 4, 6-7, 9-10; APPLE-1008, Fig. 15.

b) Claim 2

[2] The control system, according to claim 1, wherein said interactive zone of said sensor aligns with said mounting surface, said interactive zone being coplanar with said mounting surface.

398. As described above in Element [1b-iv], under Haptic's understanding of the claim limitations as evidenced by Haptic's infringement contentions (APPLE-1101, 38, 71), Li-Fixit's interactive zone (supplemental gesture surface area) aligns with the mounting surface (the inside of the phone's back cover). *Supra* §§IX.D.4.[1b-iv].



Left: APPLE-1011, 6 (step 14) (annotated)

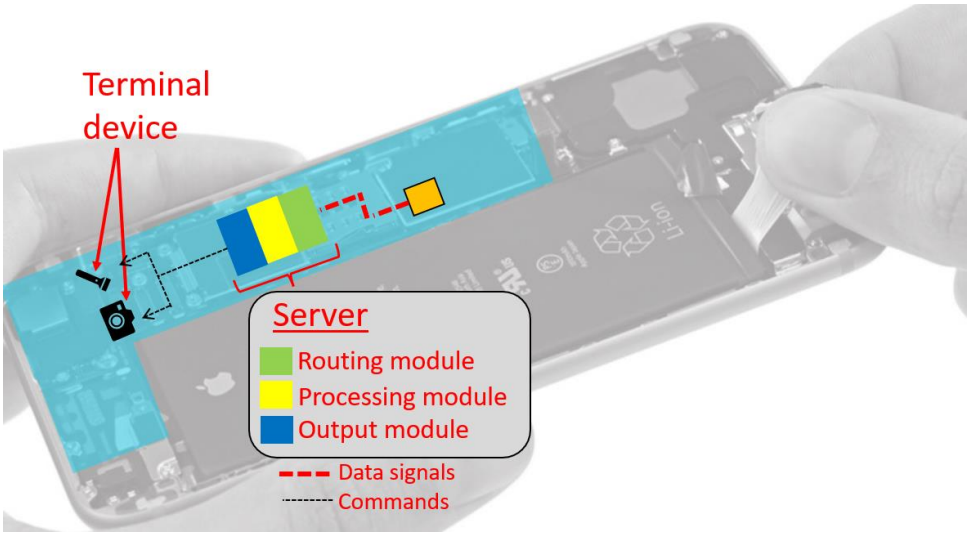
Right: APPLE-1008, Fig. 13 (annotated)

399. The interactive zone is also coplanar with the mounting surface "because the interactive zone includes the back side and sides of the iPhone." §VIII (Claim Construction); APPLE-1008, [0030], [0022], [0023], [0030], Figs. 13, 15; APPLE-1011, 4, 6-7, 9-10; APPLE-1101, 38, 71. Accordingly, Li-iFixit renders this claim obvious, consistent with Haptic's understanding of the claim as evidenced by the infringement contentions.

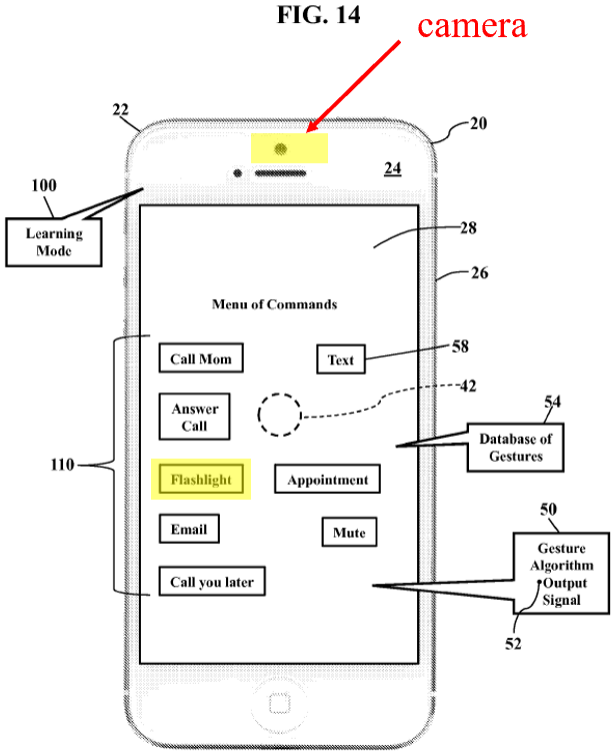
c) Claim 8

[8] The control system, according to claim 1, wherein said terminal device is comprised of one device selected from a group consisting of: a television, a thermostat, a computer, a software system, a game console, a fan, a mattress adjustor, an alarm clock, and a lighting fixture.

400. Under Haptic's construction of a "terminal device" (§VIII), Li-iFixit includes a flashlight as a terminal device (i.e., the claimed lighting fixture). APPLE-1008, Fig. 14; *see also* APPLE-1011, 5, 6.



APPLE-1011, 5 (modified and annotated)



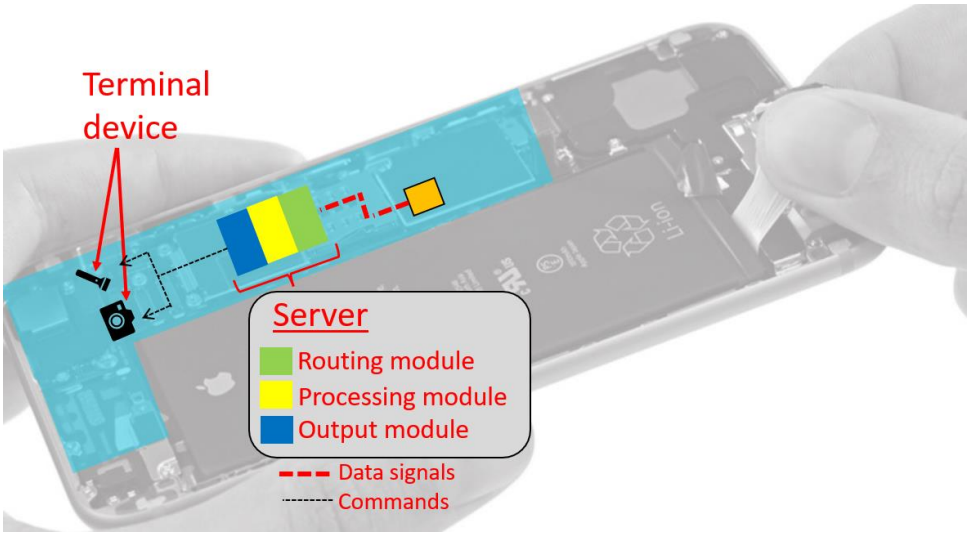
APPLE-1008, Fig. 14 (annotated)

d) Claim 9

[9] The control system, according to claim 1, further comprising: an additional terminal device being comprised of an additional receiving module and additional means for initiating activity of said additional terminal device corresponding to an additional command, said additional terminal device being in communication with said server, said output module transmitting said additional command to said additional receiving module.

401. Under Haptic's apparent understanding of this claim as evidenced by the infringement contentions, Li-iFixit includes multiple terminal devices, each comprised of a receiving module and a means for initiating activity of the terminal device corresponding to a terminal device-specific command, wherein each terminal device is in communication with the server and the output module transmits a command to a corresponding terminal device. *See* §§IX.D.4.[1d-i] (Ground 2A); APPLE-1008, [0020], [0022]-[0023], [0031]-[0033], [0093], Fig. 14; APPLE-1101, 39-40, 73.

402. For example, Li describes that user gestures can be used to control the phone's flashlight or "to execute a command, such as transitioning to a different display screen, answering a call, capturing a photo, or any other action." APPLE-1008, [0020], Fig. 14. In Haptic's infringement contentions, Haptic identifies "the iPhone's camera [and] flashlight" as examples of two terminal devices. APPLE-1101, 29. Accordingly, Li-iFixit provides at least an iPhone camera as a first terminal device and an iPhone flashlight as a second "additional" terminal device. APPLE-1008, [0020], Fig. 14; *see also* APPLE-1101, 29.



APPLE-1011, 5 (modified and annotated)

403. Each of the camera and the flashlight includes a receiving module and means for initiating activity, consistent with Haptic's infringement contentions. APPLE-1101, 29 ("Each of terminal devices comprised of a receiving module internal to the iPhone include at least the iPhone's camera, flashlight, speaker, lock controls, audio player, volume up, volume down, smartphone GUI…."), 32 ("For terminal device internal to the iPhone, the "means for initiating activity" is the switch, transistor, physical actuator, or other actuating mechanism that activated the terminal device, e.g., the connection that activates the iPhone's flashlight…other terminal device (e.g., alarm clock, Siri, cellular telephone, etc.) internal to the iPhone [] are actuated by a switch or other actuating mechanism that may be a switch hardware component [or other types of switch including programming]").

404. Li discloses that user gestures can be used to control the phone's flashlight or "to execute a command, such as transitioning to a different display screen, answering a call, capturing a photo, or any other action." APPLE-1008, [0020], Fig. 14. Accordingly, in Li-iFixit, the terminal device (camera) and additional terminal device (flashlight) are both in communication with the server and capable of receiving an instruction from the output module of the server to control each the device.

405. Accordingly, under Haptic's apparent understanding of the claim term, Li-iFixit includes at least a first terminal device and an additional terminal device having the claimed characteristics and functions. APPLE-1101, 39-40, 73.

e) Claim 10

[10pre]-[10k-i]

406. Li-iFixit renders obvious elements [10p]-[10k-i]. *Supra* §§IX.D.4.[1pre]-[1e] (Ground 2A). As described above, although claim 10 is a method claim, the elements of claim 10 correspond substantively with the claim elements of claim 1 and are rendered obvious by Li-iFixit for the same reasons presented above with regard to the elements of claim 1.

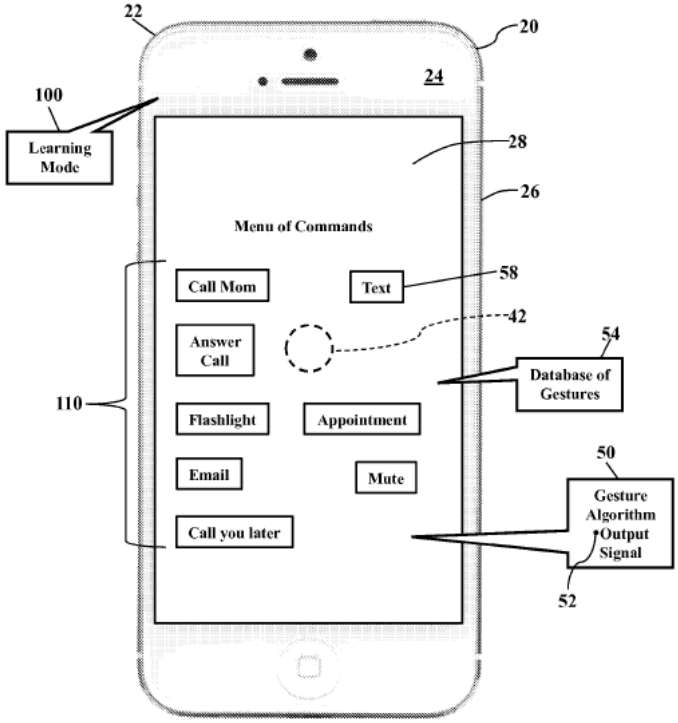
[10k-ii] said command corresponding to activity of said terminal device; and

407. Li-iFixit's command (e.g., command 58) corresponds to activity of the terminal device (e.g., "transitioning to a different display screen, answering a call,

capturing a photo, or any other action"). APPLE-1008, [0020], [0022], [0032]. Li describes that a gesture detection method uses a "database 54 of gestures maps, associates, or relates different output signals 52 to their corresponding commands 58." *Id.*, [0022].

408. Li's Fig. 14 shows "a menu 110 of the commands 58" that "is stored and retrieved from the memory." APPLE-1008, [0031]. To set up correspondence between a gesture, command, and activities of the iPhone components in the gesture detection method, Li describes that "[t]he user touches or selects the command 58 that she wishes to associate to the gesture (e.g., the output signal 52) [and] the processor… adds a new entry to the database 54 of gestures." *Id.* "The database 54 of gestures is thus updated to associate the output signal 52 to the command 58 selected from the menu 110." *Id.*

FIG. 14



APPLE-1008, Fig. 14

409. Li further describes that when a user performs a gesture, the database is queried to match the sensed gesture to a stored gesture profile. *Id.*, [0022]. "Should a match be found, the processor 30 retrieves the corresponding command 58 [and] executes the command." *Id.* Accordingly, Li-iFixit describes that the command (transmitted to the terminal device) corresponds to a particular activity of the terminal device.

[10l] performing said activity with said terminal device.

410. Li-iFixit performs the activity with the terminal device. APPLE-1008, [0020], [0022]-[0023], [0035]. As described above, in Li-iFixit, when a sensed gesture is matched to a stored gesture profile, the command is retrieved and executed. *Id.*, [0022]. For example, as a result of the processor executing a command, Li-iFixit's terminal devices "transition[] to a different display screen, answer[] a call, captur[e] a photo, or [perform] any other action." APPLE-1008, [0020]. Accordingly, in Li-iFixit, the terminal device performs the activity associated with the command received from the server.

E. GROUND 2B: THE LI-iFIXIT-SACHS COMBINATION RENDERS CLAIMS 4-5 AND 11 OBVIOUS

411. Discussion below covers Ground 2B under Haptic's apparent understanding of the claim terms as evidenced by the Joint Claim Construction statement and infringement contentions. *See generally* APPLE-1101; APPLE-1107. In the below discussion, I refer to Haptic's infringement contentions (APPLE-1101), as well as to the claim construction section above when necessary to explain Haptic's apparent understandings of certain claim terms.

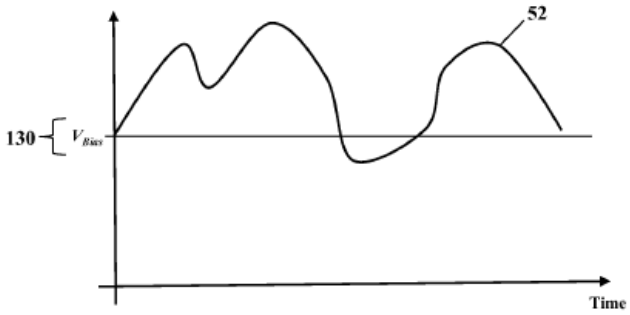
1. Li-iFixit-Sachs Combination

a) The Combination

412. Li discloses that the gesture detector 42 provides an output signal 52 based on the detected vibrations. APPLE-1008, [0037] ("the gesture detector…

generates the output signal 52"). In Li's system, "the processor 30 receives the output signal 52 and queries a database 54 of gestures… [which] maps, associates, or relates different output signals 52 to their corresponding commands 58." *Id.*, [0022]. "The processor 30 compares the output signal 52 to the entries stored in the database 54 of gestures [and, should] a match be found, the processor 30 retrieves the corresponding command 50." *Id.* As illustrated in FIG. 17, Li's output signal includes peaks and valleys, with a time period between peaks and after the last peak, but Li is silent with respect to extraction of these or other particular data features for comparison to mapped gesture data or to any particular processing that would identify these features to be used in the comparison of the output signals to the database of gestures. *Id*., Fig. 17. iFixit is also silent as to the processing of vibration data sensed by the accelerometer.

FIG. 17



APPLE-1008, Fig. 17

413. Li acknowledges that "the output signal 52 may have too much data for fast processing…[e]ven though the gesture is only one second in duration, the output signal 52 may still contain too much data for quick processing." APPLE-1007, [0037]. Li suggests sampling "the output signal 52 to produce discrete data points 132" for processing and comparison. *Id.,* [0038]. "When the database 54 of gestures is queried, exemplary embodiment need only match the sample values and not an entire, continuous voltage, charge or current signal." *Id.*, [0039]. "The burden on the processor 30 is thus reduced, yielding a quicker response to the user's gesture input." Based on Li's description of sampling the signal to ease processing requirements, a POSITA would have been motivated to look for references that describe ways to process sensed signals for efficient use of

processing power while still being able to match a sensed signal to a particular gesture.

414. A POSITA would have been motivated to look to references similar to Li, such as Sachs, for additional information about how to process vibratory data to distinguish between gestures that a user makes on a surface of a device. While Li describes simple sampling of the signal data, Sachs provides additional guidance as to data features in the sensed data that are useful in detection of a particular gesture.[10] Like Li, Sachs also describes processing signals detected by an accelerometer within a mobile device when a user taps on the body of the device. APPLE-1007, [0009] ("such functionality can include motion gesture recognition implemented on motion sensing devices to allow a user to input commands or data by moving the device or otherwise cause the device sense the user's motion [f]or example… tapping the device."), [0101] ("A tap gesture typically includes the user hitting or tapping of the device 10 with a finger, hand, or object sufficiently to cause a large pulse of movement of the device in space"); *see also id.*, [0009]-[0012], [0036], [0101]; APPLE-1008, [002], [0023], [0030], [0033]. The problem

[10] See my discussion of Sachs' teachings above with regard to Ground 1B. Although Sachs is applied to a different combination of references here, Sachs' teachings to identify particular data features are applicable to both combinations.

of detecting and recognizing tap-based gestures in an electronic device was well-known by the Critical Date, and indeed, the teachings of Sachs regarding data features that can be used to identify such gestures would have been commonly known by a POSITA by that time. APPLE-1009, [0003], [0006] ("there is a need for proving a multiplicity of tap commands in the aforementioned small mobile devices."). Well before the Critical Date, accelerometers within electronic devices were being used for detection of taps on the outside of the device. *See e.g., id.*, [0010] ("The accelerometer is located inside the device such that when the device is tapped, the shock is translated to [the] accelerometer properly."), [0017] ("The accelerometer chip preferably includes its own dedicated processor that executes the foregoing tap detection algorithm…[a]lternatively, the host processor could be programmed itself to receive the 3 inputs from the accelerometer and execute the tap detection algorithm.").

415. Sachs describes processing gesture data to determine a user's intended instruction and the corresponding intended command – for example whether a gesture is interpreted as two or three taps. APPLE-1007, [0102]-[0104], Figs. 11A-B. In tap detection, "[t]he timing of the two taps determines whether the command was a double tap or two individual single taps." APPLE-1009, [0013]; *see also id.*, [0014], [0034], [0037]-[0038], [0041]. Sachs describes various data features that are useful to identify in vibration data to determine a particular

gesture from the data. APPLE-1007, [0102], [0120], [0123], Figs. 11A-B. A POSITA, motivated to combine Li, iFixit, and Sachs, would have done so by implementing the Li-iFixit processing of the output signal with Sachs' teachings to identify large magnitude pulses, timing between features, and a predetermined period of time following a final feature in order to identify key aspects of the vibratory signals to match to a user command. APPLE-1007, [0094], [0079], [0101]-[0102].

b) Reasons for the Combination

416. A POSITA would have been motivated to pursue the Li-iFixit-Sachs combination and possessed a reasonable expectation of its success in arriving at the claimed invention for at least the following independent reasons.

417. First, a POSITA would have been motivated to implement the Li-iFixit apparatus to clearly segment the output signal into components that can be efficiently compared to the database of gestures. APPLE-1007, [0010], [0079]; AS described above, Li recognizes that without limiting the number of signal data points detected by the gesture detector, the signal "may have too much data for fast processing." APPLE-1008, [0037]; *see also id.*, [0037]-[0039]). Li's sampling technique limits the number of values or points to be compared. APPLE-1008, [0039] ("When the database 54 of gestures is queried, exemplary embodiments need only match the sampled values and not an entire, continuous voltage, charge,

or current signal."). Sachs describes that processing loads associated with identifying user gestures based on the vibration data can be reduced "by extracting important features from the sensor data, such as the magnitude of peaks in the motion waveform, or the particular times of zero crossings." APPLE-1007, [0120]. A POSITA would have understood that Sachs' teaching to identify key aspects of the signal is a variation on Li's sampling method that decreases the number of points that need to be matched to identify a gesture from the sensed data.

418. Second, by identifying data features in the sensed data that can be compared to mapped gesture data, as Sachs teaches, the identified data features (such as waveform peaks and timings of features) can be compared to mappings of user inputs to desired commands, rather than comparing the entire signal. APPLE-1007, [0120]. This not only reduces the processing load by limiting the number of sampled points to be processed and compared, in line with Li's teachings, but also allows natural variations in the user's input to be accommodated – for example, minor differences in timing of inputs can be tolerated and the correct command can be identified. *Id.*, [0015], [0078]-[0080], [0120]; APPLE-1008, [0037]-[0039]. A POSITA would have been motivated to implement the gesture detection system as taught by Li-iFixit with Sachs' teachings to reduce processing load by comparing important data features to identify a gesture.APPLE-1007, [0015] ("The use of data

features in motion sensor data allows gestures to be recognized with reduced processing compared to processing all the motion sensor data"), [0010], [0079]; *see also* APPLE-1008, [0039] ("The burden on the processor 30 is thus reduced, yielding a quicker response to the user's gesture input."). This goal of both the Li and Sachs references would have motivated a POSITA to make the combination of Li-iFixit-Sachs.

419. Third, a POSITA would have been motivated to implement the Li-iFixit gesture algorithm to identify large magnitude pulses associated with taps, as Sachs teaches, to identify user taps on the device body above any background noise. APPLE-1007, [0102]. It was well understood by the Critical Date that the motion of a device in response to a tap must be "distinctly above the level of the background noise" in order to accurately detect user inputs." APPLE-1009, [0014], [0011] (describing that "the peak rises to a maximum"), [0031], [0036] ("The performance index of a tap is distinctly above the level of background noise…[and a] tap event is detected when the…jerk summation exceeds the performance index lower threshold"), *see also* APPLE-1009, [0036]-[0038], [0041] ("Thresholding of the performance index and timing considerations identify taps and distinguish between single or double tap providing two distinct commands"). Sachs describes that "detecting a tap gesture is performed by examining motion sensor data to detect a gesture relative to a background noise

floor." *Id.*, [0102], [0084]. "[A]n actual intended tap gesture produces a pulse magnitude 282 far above [the background] noise level 284" when the device including the sensor is held loosely in a user's hand. *Id.*, [0102]. However, when the sensor is located on the surface on which the tap is performed, as in Murakoshi, the "tap gesture produces a much smaller magnitude pulse 290" but still "typically far above the noise level 292." *Id.* Sachs describes that "if the background noise level is considered in the tap detection, tap gestures can be detected more robustly. *Id.* A POSITA would have understood that background noise may interfere with the correct identification of a user input and would therefore have been motivated to use Sachs' teaching to identify signal components corresponding to large magnitude pulses to correctly identify user taps. *Id.*, [0102]-[0104], Figs. 12A-B.

420. Fourth, a POSITA would have been motivated to implement the Li-iFixit gesture algorithm to identify timing between features (e.g., taps), as Sachs teaches, to provide flexibility in recognition of gestures while still distinguishing between different user commands. APPLE-1007, [0079], [0010], [0090], [0101]-[0104]. As I've explained above, different users may perform gestures with slightly different timings, and indeed even the same user would find it difficult to perform a gesture in the same exact manner each time. Sachs recognizes that solutions that "hard-code or train all possible variations of a gesture" are "expensive in processing time and difficult to implement." *Id.*, [0010]; *see also*

[0078] ("If the required timing values are hard-coded, then many different ranges of values will need to be stored, and it will be difficult to cover all possible user variances and scenarios"). Sachs describes a system that "recognizes gestures using relative timing requirements" by measuring the time period between identified data features (e.g., between peaks) and using the measured time to recognize a particular gesture. *Id.*, [0078]-[0079]. As described above, measuring timing between data features provides an important feature for identifying a particular feature and allows a user to have the desired effect on controlling a terminal device, despite imperfections or deviations from a mapped input. This was not a new idea, and the teachings of Sachs were commonly applied to similar technologies where different tap signals needed to be differentiated. *See e.g.*, APPLE-1009, [0041] ("Thresholding of the performance index and timing considerations identify taps and distinguish between single or double tap providing two distinct commands"), [0013] ("The timing of the two taps determines whether the command was a double tap or two individual taps"), [0014] ("the timing between two occurrences (or absence of a second PI peaks) of high PI are used to distinguish between single and double taps"); *see also* APPLE-1009, [0034]-[0035], [0037].

421. Fifth, a POSITA would have been motivated to implement the Li-iFixit gesture algorithm to clearly signal that the user tap gesture is completed, as

Sachs teaches, so that it can be determined when a user input is finished and can be matched to a user intended command. APPLE-1007, [0079]. A POSITA would have understood that it is important to provide a period of time following the last detected data feature (or other gesture end mechanism) to determine the end of a gesture. *See e.g.*, APPLE-1009, [0014] (describing "absence of a second…peak" in order "to distinguish between single and double taps"), [0037] ("a latency timer sets the time period that a tap event will only be characterized as a single tap"), [0038], [0041]. Such a predetermined period of time following a detected gesture would allow for the determination that a gesture is a single or double tap, allow for identifying the end of a scratching pattern, or allow for differentiation between various gestures that form shapes or letters. APPLE-1007, [0107]-[0109] (explaining gestures including a circle gesture, letters, numbers or other symbols); APPLE-1004, [0035] ("Examples of the gesture may include, but are not limited to, drawing s shape and/or drawing an alphanumeric character"), [0050] (explaining that a user may interact with the vibratory surface by drawing a circle or other gesture on the surface), [0074]-[0075] (describing a user drawing letters on the vibratory surface). For example, a POSITA would have been motivated to implement Murakoshi-Stewart's system with Sachs' teaching to wait a period of time following an impact to determine whether the user gesture includes an additional impact (e.g., a single or double tap). APPLE-1007, [0112] ("For

example, three shake gestures may be required to be detected, in succession, to detect the three as a single gesture and to implement the function(s) associated with the shake gesture [or in another example] three tap gestures may be required to be detected instead of just one.").

422. Sixth, a POSITA would have understood that implementing Sachs' teachings to identify key features of the output signal such as maximum peaks, timing between features, and a time period following a final input in the context of the Li-iFixit gesture algorithm would have yielded predictable results from combining known elements according to known methods. As Sachs describes, the identification of patterns in sensed data to be used to identify a gesture and associate the gesture with a desired response or command was well-known and there were various methods for identifying patterns in the data. In particular, Sachs describes that "[p]rior gesture recognition for motion sensing devices typically consist[ed] of examining raw sensor data such as data from gyroscopes or accelerometers, and either ***hard-coding patterns to look for*** in this raw data, or using machine learning techniques (such as neural networks or support vector machines) ***to learn patterns from this data***." APPLE-1007, [0009] (emphasis added). A POSITA would have understood that both Li and Sachs describe systems that receive user inputs and process the inputs to determine an associated user intended command. APPLE-1008, [002], [0023], [0030], [0033]; APPLE-

1007, Abstract, [0079]. Because the types of user inputs and signals resulting from the user inputs (e.g., accelerometer vibration signals), a POSITA would have been confident that the types of data features that Sachs teaches as being components of a data pattern for identifying a gestures could be applied in Li-iFixit's system and would have had a reasonable expectation of success in the combination. In the combination, each element performs a similar function as it does in the reference – that is, the iPhone accelerometer detects vibrations as described above in the Li-iFixit combination, and processing occurs at the processor (per Li-iFixit, as described above) with the teachings of Sachs to identify particular additional data features for mapping the data signal to a gesture. In particular, because the combination relies on the combination of the teachings of the references rather than bodily incorporation, a POSITA would have understood that Sachs' teachings that particular data features are useful in identifying a user gesture quickly and without requiring a large amount of computing power could be implemented in processing data signals sensed by an iPhone accelerometer, per Li-iFixit.

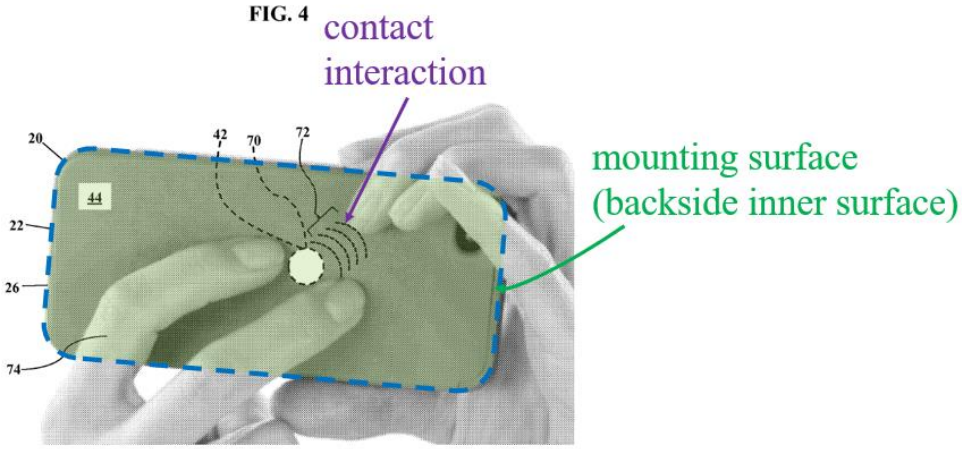
423. Applying and combining these concepts would have been obvious from a POSITA's perspective, at least because processing of vibration data to extract impact and timing information was well-known by the Critical Date, as described above. Augmenting a processor to identify data features taught by Sachs would have been well within a POSITA's skill level. A POSITA would have

expected that identifying the additional data signal components described by Sachs could be accomplished by simply adding additional parameters and thresholds to the instructions executed by a processor, per Li-iFixit. Applying and combining these concepts would have been obvious from a POSITA's perspective, and a POSITA would have had a reasonable expectation of success in doing so for all of the above reasons.

c) Claim 4

[4a] The control system, according to claim 1, wherein said contact interaction is comprised of an impact on said mounting surface,

424. As described above (*supra* §§IX.D.4.[1b-vi] (Ground 2A)), in the Li-iFixit combination, a user's gesture (such as a tap) on the back of an iPhone is a contact interaction comprising an impact on the mounting surface, consistent with Haptic's understanding of the claim element as evidenced by the infringement contentions and briefing in the co-pending District Court litigation. APPLE-1101, 12, 46; APPLE-1008, [0022], [0023], Fig. 4; *see also* APPLE-1104, 9. For example, Li's Figure 4, illustrates a user tapping on the backside of the phone. APPLE-1008, Fig. 4. Under Haptic's understanding of the claim language, Li-iFixit's disclosure of tapping on the back of the phone satisfies "said contact interaction being comprised of an impact on said mounting surface."



APPLE-1008, Fig. 4 (annotated)

[4b] said data signals having a respective defined peak corresponding to each impact, a defined time period after a last defined peak, said data pattern being comprised of each defined peak and said defined time period after said last defined peak.

425. The Li-iFixit-Sachs combination processes data signals (output signal 52) to identify a large-magnitude pulse associated with the interaction (respective defined peak corresponding to the impact) and a predetermined period of time after an interaction (a defined time period after a last defined peak) for determining the gesture is complete. §IX.E.1 (Li-iFixit-Sachs Combination). Sachs describes that data features (i.e., a data pattern) are identified from the raw data associated with a tap gesture. APPLE-1007, [0015], [0079], [0096], [0120].

426. Sachs' data features include a large magnitude pulse detected above the background noise floor (a defined peak corresponding to the impact). APPLE-1007, [0102]. Sachs also describes that the data features associated with a gesture

can include a predetermined period of time following the gesture during which no additional large-magnitude pulses are detected. APPLE-1007, [0094] ("A shaking gesture can be determined to be complete once a predetermined period of time passes during which no additional large-magnitude pulses are detected").

427. A POSITA would have understood, based on Sachs' discussion of the predetermined time period, Sachs' predetermined time period is a defined time period after a last peak for determining if a gesture is complete. APPLE-1007, [0094].

428. Additionally, a POSITA would have understood that as discussed above in §§IX.D.4.[1c-vi] (Ground 2A), Li's description of the processor "interpreting" the gesture input is meant as the identification of a data pattern representative of the vibration data signals in order to determine which gesture the user performed on the back of the phone for matching the gesture to an intended instruction to control the phone. Li describes that the processor matches the data pattern to a stored gesture (gesture profile) associated with a command by "compar[ing] the output signal 52 to the entries stored in the database 54 of gestures … [and] retriev[ing] the corresponding command 58." APPLE-1008, [0022]; *see also id*., [0032] ("[g]estures may be predefined to invoke or call commands, functions, or any other action").

429. A POSITA would have understood that in the Li-iFixit-Sachs combination, the data pattern that the processor matches to the stored gesture profile in the database of gestures includes the data features identified by Sachs to provide efficient processing and matching of the gestures, while also allowing for minor variations in the way a user inputs gestures. *Supra* §IX.E.1 (Li-iFixit-Sachs Combination).

d) Claim 5

[5a] The control system, according to claim 1, wherein said contact interaction is comprised of a plurality of impacts on said mounting surface,

430. AS described above in §IX.D.4.[1b-vii] (Ground 2A) and in §IX.E.2.[4a] (Ground 2B), in Li-iFixit-Sachs user gestures comprise an impact on the mounting surface, consistent with Haptic's understanding of the claim limitation as evidenced by the infringement contentions. APPLE-1101, 12, 46; APPLE-1008, [0022], [0023], Fig. 4; *see also* APPLE-1104, 9.

431. Additionally, Li-iFixit-Sachs' contact interaction comprises a plurality of impacts (e.g., "taps") on the mounting surface. APPLE-1008, [0020]-[0023]; *see also* APPLE-1007, [0112] ("three tap gestures"). Li describes that "the user may associate any gesture to any action." APPLE-1008, [0020]; *see also* Fig. 12 (learning mode screen). "The gesture detector 42 recognizes simple taps and swipes, more complex geometric shapes, and even alphanumeric characters." *Id.*, [0021].

432. As described above, a POSITA would have recognized Li's description of multiple taps (or Sachs', for that matter) on the vibratory surface to be "an impact" on the mounting surface. *See e.g.*, APPLE-1047 ("A tap is simply a synonym for a light strike, pat or rap that causes an object to undergo acceleration."); APPLE-1007, [0101] ("A tap gesture typically includes the user hitting or tapping of the device 10 with a finger, hand, or object").

[5b] said data signals having a respective defined peak corresponding to each impact, a measured time period between each defined peak, and a defined time period after a last defined peak, said data pattern being comprised of each defined peak, each measured time period, and said defined time period after said last defined peak.

433. Limitation [5b] of claim 5 includes the features of limitation [4b] of claim 4 (a respective defined peak corresponding to each impact, a defined time period after a last defined peak), and adds an additional data feature (a measured time period between each defined peak). Li-iFixit renders obvious the shared features (a respective defined peak corresponding to each impact, a defined time period after a last defined peak) for the same reasons described above in Element [4b]. *Supra* §IX.E.2.[4b] (Ground 2B); APPLE-1007, [0101]-[0102], [0094].

434. Additionally, with regard to the "measured time period between each defined peak," Sachs describes that a flexible recognition of gestures can rely on identification of data features including the timing between different features in the gesture motion data (a measured time period between each defined peak). APPLE-

1007, [0079]. Sachs describes that "the timing between different features in motion data can be expressed and detected based on multiples and/or fractions of a basic time period used in that gesture… [t]he basic time period can be, for example, the time between two data features." *Id.* Indeed, the data features described by Sachs are not unique to Sachs, and are common sense features that a POSITA would have known to extract for purposes of comparing to stored values. *See e.g.,* APPLE-1009, Fig. 5, [0014] ("the timing between two occurrences… of high PI are used to distinguish between single and double taps"), [0016] ("timing considerations identify taps and distinguish between single or double taps providing two distinct commands"), [0037] ("a latency timer").

435. Finally, for the same reasons described above, Li-iFixit-Sachs also provides that the data pattern that the processor matches to the stored gesture profile in the database of gestures includes the data features identified by Sachs to provide efficient processing and matching of the gestures, while also allowing for minor variations in the way a user inputs gestures. *Supra* §IX.E.1 (Li-iFixit-Sachs Combination), §IX.E.2.[4b] (Ground 2B). As explained above, detecting a timing between features (such as peaks), allows for easier comparison of the gesture data to mapped gestures to identify the intended gesture without excessive use of computational resources. *Id*., [0078]-[0079], [0096], [0126]-[0127]; §IX.E.1 (Li-iFixit-Sachs Combination).

e) Claim 11

[11] The method of controlling the terminal device, according to claim 10, wherein the step of making a physical impact on said mounting surface further comprises making a plurality of physical impacts on said mounting surface, said contact interaction being associated with more than one physical impact.

436. Li-iFixit-Sachs renders this element obvious for the same reasons described above with regard to element [5a] of claim 5. *Supra* §IX.E.2.[5a] (Ground 2B). Claim 11 requires that the physical impact on the mounting surface is a plurality of physical impacts. As explained above with regard to claim 5, Li and Sachs both make clear that a user can make a gesture that includes a plurality of impacts (e.g., taps) on a surface. *Supra* §IX.E.2.[5a] (Ground 2B); APPLE-1008, [0020]-[0023]; *see also* APPLE-1007, [0112] ("three tap gestures").

CONCLUSION

437. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

APPENDIX A

Dr. Benjamin B. Bederson
University of Maryland, College Park
Professor Emeritus, Computer Science

bederson@umd.edu
www.cs.umd.edu/~bederson

I have read the following and certify that it is a current and accurate statement of my professional record as of September 13, 2024.



1. PERSONAL INFORMATION

EDUCATION

9/89 – 6/92	**Ph.D., New York University, Computer Science Dept.**	**New York, NY**
9/87 – 8/89	**M.S., New York University, Computer Science Dept.**	**New York, NY**
9/82 – 6/86	**B.S., Rensselaer Polytechnic Institute, Computer Science Dept.** **Minor, Electrical Engineering**	**Troy, NY**

EMPLOYMENT & ROLES

3/22 – Present	**J.S. Bryant School, Inc.** Therapeutic high school for LGBTQ+ students Co-founder, Chief Operating Officer, Board member, Treasurer and Clerk	**Cummington, MA**
1/19 – Present	**Bederson Expert Services, Inc.** Technical and expert witness consulting	**Windsor, MA**
1/98 – Present	**University of Maryland, Computer Science Dept./UMIACS** 7/19 – Present: Professor Emeritus, Computer Science Department. 4/14 – 6/18: Associate Provost of Learning Initiatives, and Executive Director of Teaching and Learning Transformation Center 4/13 – 4/14: Special Advisor to the Provost on Technology and Educational Transformation 8/11 – 6/19: Professor 9/04 – 7/11: Associate Professor 6/00 – 9/06: Director of the Human-Computer Interaction Lab (HCIL) 1/98 – 8/04: Assistant Professor	**College Park, MD**
1/06 – Present	**International Children's Digital Library Foundation** Co-founder and Technical Director for this library of exemplary free online children's books from around the world. 7/17 – present: President, secretary and treasurer	**Windsor, MA**
10/14 – 4/23	**Hazel Analytics, Inc.** Co-founder & Board member: regulatory data analytics 10/14 – 12/19: Chief Technology Officer	**Seattle, WA**
9/06 – 10/14	**Zumobi, Inc.** Co-founder of VC-funded startup for mobile apps and advertising. 9/06–1/08: VP Client Technologies 1/08–10/14: Chief Scientist	**Seattle, WA**
6/03 – 11/08	**Windsor Interfaces, Inc.** Founder: Small company to commercialize HCIL products.	**Chevy Chase, MD**
1/95 – 8/97	**University of New Mexico, Computer Science Department** Assistant Professor in the Computer Science Department.	**Albuquerque, NM**
9/92 – 8/94	**Bell Communications Research (Bellcore)** Research Scientist in Computer Graphics and Interactive Media group.	**Morristown, NJ**

6/93 – 7/94	**New York University, Media Research Laboratory** Visiting Research Scientist.	**New York, NY**
9/90 – 8/92	**Vision Applications, Inc.** Research Scientist.	**New York, NY**
9/88 – 6/90	**New York University, Computer Science Department** Teaching Assistant.	**New York, NY**
1/87 – 5/87	**North Slope Borough/North Slope Higher Education Center** Instructor. Taught Computers & Society to rural Eskimo population.	**Barrow, AK**

2. RESEARCH, SCHOLARLY, AND CREATIVE ACTIVITIES

Note about publications:

- In all references, my name is in bold.
- Authors are displayed as published. Authors are usually listed in order of decreasing contribution – except that sometimes the last author is the lead advising faculty member. I put an asterisk next to my name when I served that role.
- Students that I supervised are underlined.

A. BOOKS

i. Authored Books

1. Herrnson, P.S., Niemi, R.G., Hanmer, M.J., **Bederson, B. B.**, Conrad, F.G., Traugott, M., (2008) "Voting Technology and the Not-So-Simple Act of Casting a Ballot," *Brookings Institute Press*.

ii. Edited Collections

1. Teevan, J., Jones, W., **Bederson, B. B.** (Eds.) (2006) *Communications of the ACM (CACM)*, Editors of special issue on "Personal Information Management", 49 (1), ACM Press.
2. **Bederson, B. B.**, Shneiderman, B. (Eds.) (2003). *The Craft of Information Visualization: Readings and Reflections*. San Francisco: Morgan Kaufmann.

iii. Book Chapters

1. Fails, J., Druin, A., **Bederson, B. B.**, Weeks, A., & Rose, A. (2009) A Child's Mobile Digital Library: Collaboration, Community and Change. Druin, A. (Ed.) *Mobile Technology for Children: Designing for Interaction and Learning,* Morgan Kaufmann Press.
2. Herrnson, P.S., Niemi, R.G., Hanmer, M.J., **Bederson, B. B.**, Conrad, F.G., Traugott, M.W. (2008) The Current State of Electronic Voting in the United States. Chen, H., Brandt, L., Dawes, S., Gregg, V., Hovy, E., Macintosh, A., Traunmüller, R., Larson, C. (Eds.) *Digital Government: Advanced Research and Case Studies,* Springer, 157-180.
3. Karlson, A., **Bederson, B. B.**, & Contreras-Vidal, Jose L. (2007) Understanding One Handed Use of Mobile Devices. Lumsden, Jo (Ed.), *Handbook of Research on User Interface Design and Evaluation for Mobile Technology,* Idea Group Reference, 86-101.
4. Hutchinson, H., Druin, A., **Bederson, B. B.** (2007) Designing Searching and Browsing Software for Elementary-Age Children. Lazar, J. (Ed.), *Universal Usability*. John Wiley. 1618-1630.
5. Druin, A., **Bederson, B. B.**, Boltman, A., Muira, A., Knotts-Callahan, D., & Platt, M. (1999). Children As Our Technology Design Partners. A. Druin (Ed.), *The Design of Children's Technology* (51-72). San Francisco: Morgan Kaufmann.
6. Hollan, J. D., **Bederson, B. B.**, & Helfman, J. (1998). Information Visualization. Helander, M., Landauer, T. K., & Prabhu, P. V. (eds.), *The Handbook of Human Computer Interaction* (Chap. 2, 33-48). Amsterdam: Elsevier Press.

7. **Bederson, B. B.**, Hollan, J. D., Stewart, J., Rogers, D., Druin, A., Vick, D., Ring, L., Grose, E., & Forsythe, C. (1997). A Zooming Web Browser. C. Forsythe, J. Ratner, & E. Grose (eds.), *Human Factors and Web Development* (Chap. 19, 255-266). New Jersey: Lawrence Erlbaum.
8. **Bederson, B. B.**, & Druin, A. (1995). Computer Augmented Environments: Physical Spaces to Enrich Our Lives. Jakob Nielsen (eds.), *Advances in Human-Computer Interaction* (Vol. 5, Chap. 2, 37-66). New Jersey: Ablex Press.
9. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (1993). A Miniaturized Space-Variant Active Vision System: Cortex-I. Richard Mammone (eds.), *Artificial Neural Networks for Speech and Vision*. Chapman-Hall Publishers.
10. Wallace, R. S., Ong, P.-W., **Bederson, B. B.**, & Schwartz, E. L. (1993). Connective Graphs in Space-Variant Active Vision. George A. Bekey & Ken Goldberg (eds.), *Neural Networks in Robotics*. Kluwer Academic Publishers.

B. REFEREED ARTICLES
i. Journals

1. **Bederson, B. B.**, Jin, G. Z., Leslie, P., Quinn, A. J., Zou, B. (2017) "Incomplete Disclosure: Evidence of Signaling and Countersignaling", in *American Economic Journal: Microeconomics*, (in press).
2. Anderson, L. B., Gardner, E. E., Wolvin, A., Kirby-Straker, R., Yalcin, A., & **Bederson, B. B.*** (2016), "Incorporating Learning Analytics into Basic Course Administration: How to Embrace the Opportunity to Identify Inconsistencies and Inform Responses", in *Journal of the Association for Communication Administration*, 35 (1), Winter-Spring 2016, pp 2-14.
3. Lee, T. Y., **Bederson, B. B.*** (2016) "Give the people what they want: studying end-user needs for enhancing the web", *PeerJ Computer Science,* Nov, 2016, 2:e91 https://doi.org/10.7717/peerj-cs.91
4. Yalcin, M. A., Elmqvist, N. &, **Bederson, B. B.***. (2015) "AggreSet: Rich and Scalable Set Exploration using Visualizations of Element Aggregations". in *IEEE Transactions on Visualization and Computer Graphics*, 22(1), 688–697, 2015.
5. Hu, C., Resnik, P., & **Bederson, B. B.*** (2014) "Crowdsourced Monolingual Translation", in *ACM Transactions on Computer-Human Interaction (TOCHI)*, 21 (4), Aug 2014, pp. 22:1–22:35.
6. Lee, T.Y., Mauriello, M., Ahn, J. & **Bederson, B. B.*** (2014) "CTArcade: Computational Thinking with Games in School Age Children", in *International Journal of Child-Computer Interaction*, 2 (1), Jan 2014, 26–33.
7. Bonsignore, E., Quinn, A. J., Druin, A. & **Bederson, B. B.*** (2013) "Sharing Stories 'In The Wild': A Mobile Storytelling Case Study using StoryKit", in *Transactions on Computer-Human Interaction (TOCHI)*, ACM, 20 (3), July 2013, Article 18.
8. Resnik, P., Buzek, O., Kronrod, Y., Hu, C., Quinn, A.J. & **Bederson, B. B.** (2013) "Using Targeted Paraphrasing and Monolingual Crowdsourcing to Improve Translation", in *Transactions on Intelligent Systems and Technology*, ACM, 4 (3), July 2013, Article 38, 21 pages.
9. **Bederson, B. B.** (2011) "The Promise of Zoomable User Interfaces", *in Behaviour & Information Technology*, Taylor & Francis, Nov-Dec 2011, 30 (6), 853-866.
10. Druin, A., **Bederson, B. B.**, Rose, A., Weeks, A. (2009) "From New Zealand to Mongolia: Co-Designing and Deploying a Digital Library for the World's Children", *in Children, Youth and Environments*, University of Colorado, 19 (1), 34-57.
11. Conrad, F.G., **Bederson, B. B.**, Lewis, B., Peytcheva, E., Traugott, M.W., Hanmer, M.J., Herrnson, P.S., & Niemi, R.G. (2009) "Electronic voting eliminates hanging chads but introduces new usability challenges", *in International Journal of Human-Computer Studies (IJHCS)*, Elsevier Press, 67 (1), 111-124.
12. Hanmer, M.J., Park, W-H., Traugott, M.W., Niemi, R.G., Herrnson, P.S., **Bederson, B. B.**, and Conrad, F.C. (2008) "Losing Fewer Votes: The Impact of Changing Voting Systems on Residual Votes", *in Political Research Quarterly,* Sage Publications, September, 2008. doi:10.1177/1065912908324201.

13. **Bederson, B. B.**, Clamage, A., Plaisant, C. (2008) Enhancing In-Car Navigation Systems with Personal Experience, *in Transportation Research Record (TRR)*, The National Academies, 2064 (2008) 33-42.

14. Herrnson, P.S., Niemi, R.G., Hanmer, M.J., Francia, P.L., **Bederson, B. B.**, Conrad, F.G., Traugott, M. (2008) Voter's Evaluations of Electronic Voting Systems: Results from a Usability Field Study, *American Politics Research*, Sage Journals, 36 (4), July 2008, 580-611.

15. Cockburn, A., Karlson, A., & **Bederson, B. B.*** (2008) A Review of Overview+Detail, Zooming, and Focus+Context Interfaces, *ACM Computing Surveys*, ACM Press, December 2008, 41 (1).

16. Kang, H., **Bederson, B. B.**, & Suh, B. (2008) Capture, Annotate, Browse, Find, Share: Novel Interfaces for Personal Photo Management, *International Journal of Human-Computer Interaction (IJHCI)*, 23 (3), 1-23.

17. Parr, C.S., Lee, B., **Bederson, B. B.*** (2007) EcoLens: Integration and Interactive Visualization of Ecological Datasets, *Journal of Ecological Informatics*, Elsevier, 2 (1), 61-69.

18. Suh, B., and **Bederson, B. B.*** (2007) Semi-Automatic Photo Annotation Strategies Using Event Based Clustering and Clothing Based Person Recognition, *Interacting With Computers*, Elsevier, 19 (4), 524-544.

19. Hutchinson, H., **Bederson, B. B.**, Druin, A., (2007) Supporting Elementary-Age Children's Searching and Browsing: Design and Evaluation Using the International Children's Digital Library, *Journal of the American Society for Information Science and Technology*, John Wiley & Sons, 58 (11), 1618-1630.

20. Kang, H., Plaisant, C., Lee, B., **Bederson, B. B.***, (2007) NetLens: Iterative Exploration of Content-Actor Network Data, *Information Visualization*, Palgrave Macmillan, 6 (1), 18-31.

21. Lee, B., Parr, C.S., Plaisant, C., **Bederson, B. B.**, Veksler, V.D., Gray, W.D., Kotfila, C. (2006) TreePlus: Interactive Exploration of Networks with Enhanced Tree Layouts, *IEEE Transactions on Vision and Computer Graphics (TVCG)*, IEEE Press, 12 (6), 1414-1426.

22. Plaisant, C., **Bederson, B. B.**, Clamage, A., Hutchinson, H.B., Druin, A. (2006) Shared Family Calendars: Promoting Symmetry and Accessibility, *Transactions on Computer-Human Interaction*, New York: ACM, 13 (3), 313-346.

23. Shneiderman, B., **Bederson, B. B.**, and Drucker, S., (2006) Find that photo! Interface strategies to annotate, browse, and share, *Communications of the ACM,* 49 (4), 69-71.

24. Hutchinson, H.B., Rose, A., **Bederson, B. B.**, Weeks, A.C., Druin, A. (2005) The International Children's Digital Library: A Case Study in Designing for a Multi-Lingual, Multi-Cultural, Multi-Generational Audience, *Information Technology and Libraries*, 24 (1), 4-12.

25. Herrnson, P.S., **Bederson, B. B.**, Lee, B., Francia, P. L., Sherman, R.M., Conrad, F.G., Traugott, M., Niemi, R.G. (2005) Early Appraisals of Electronic Voting, *Social Science Computing Review*, 23 (3), 274-292.

26. Hourcade, J. P., **Bederson, B. B.**, Druin, A., & Guimbretière, F. (2004) Differences in pointing task performance between preschool children and adults using mice, *Transactions on Computer-Human Interaction*, New York: ACM, 11 (4), 357-386.

27. Parr, C. S., Lee, B., & **Bederson, B. B.*** (2004). Visualizations for Taxonomic and Phylogenetic Trees. *Bioinformatics*, Oxford University Press, 20 (17), 2997-3004.

28. **Bederson, B. B.**, Grosjean, J., Meyer, J. (2004) Toolkit Design for Interactive Structured Graphics, *Transactions on Software Engineering*, New York: IEEE, 30 (8), 535-546.

29. Chipman, L. E., **Bederson, B. B.,** Golbeck, J. A.(2004) SlideBar: Analysis of a Linear Input Device. *Journal of Behaviour and Information Technology*, London, Taylor & Francis, 23 (1), 1-9.

30. **Bederson, B. B.**, Clamage, A., Czerwinski, M. P., & Robertson, G. G. (2004) DateLens: A Fisheye Calendar Interface for PDAs, *Transactions on Computer-Human Interaction*, New York: ACM, 11 (1), 90-119.

31. Hourcade, J. P., **Bederson, B. B.**, & Druin, A. (2004) Building KidPad: An Application for Children's Collaborative Storytelling, *Software: Practice & Experience*, New Jersey: John Wiley & Sons, Ltd, 34 (9), 895-914.

32. Druin, A., **Bederson, B. B.**, Weeks, A., Farber, A., Grosjean, J., Guha, M. L., Hourcade, J. P., Lee, J., Liao, S., Reuter, K., Rose, A., Takayama, Y., & Zhang, L. (2003). The International Children's Digital Library: Description and Analysis of First Use. *First Monday*, *8*(5).

33. Druin, A., Revelle, G., **Bederson, B. B.**, Hourcade, J. P., Farber, A., Lee, J., & Campbell, D. (2003) A Collaborative Digital Library for Children: A Descriptive Study of Children's Collaborative Behavior and Dialogue. *The Journal of Computer-Assisted Learning*, 19 (2), 239-248.

34. Hourcade, J.P., **Bederson, B. B.**, Druin, A., Rose, A., Farber, A., Takayama, Y. (2003). The International Children's Digital Library: Viewing Digital Books Online. *Interacting with Computers*, Elsevier Press, 15 (3), 151-167.

35. Hornbæk, K., **Bederson, B. B.**, & Plaisant, C. (2002) Navigation Patterns and Usability of Zoomable User Interfaces With and Without an Overview, *ACM Transactions on Computer-Human Interaction*, 9 (4), 362-389.

36. **Bederson, B. B.**, Shneiderman, B., & Wattenberg, M. (2002) Ordered and Quantum Treemaps: Making Effective Use of 2D Space to Display Hierarchies, *ACM Transactions on Graphics*, 21 (4), 833-854, ACM Press. – **Won 2021 IEEE Vis Test of Time Award in InfoVis, http://ieeevis.org/year/2021/info/awards/test-of-time-awards.**

37. Good, L., & **Bederson, B. B.*** (2002) Zoomable User Interfaces as a Medium for Slide Show Presentations, *Information Visualization*, Palgrave Macmillan, 35-49.

38. Revelle, G., Druin, A., Platner, M., **Bederson, B. B.**, Hourcade, J.P., & Sherman, L. (2002) A Visual Search Tool for Early Elementary Science Students, *Journal of Science Education and Technology*, 11(1), 49-57.

39. **Bederson, B. B.**, & Meyer, J. (1998). Implementing a Zooming User Interface: Experience Building Pad++. *Software: Practice and Experience*, 28(10), 1101-1135.

40. **Bederson, B. B.**, Hollan, J. D., Perlin, K., Meyer, J., Bacon, D., & Furnas, G. W. (1996). Pad++: A Zoomable Graphical Sketchpad for Exploring Alternate Interface Physics. *Journal of Visual Languages and Computing*, 7, 3-31.

41. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (1995). A Miniaturized Space-Variant Active Vision System: Cortex-I. *Machine Vision and Applications*, 8 (2), 101-109.

42. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (1994). A Miniature Pan-Tilt Actuator: the Spherical Pointing Motor. *IEEE Transactions on Robotics and Automation*, 10(3), 298-308.

43. Wallace, R. S., Ong, P.-W., **Bederson, B. B.**, & Schwartz, E. L. (1994). Space-Variant Image Processing. *International Journal of Computer Vision*, 13(1), 71-90.

ii. Peer-Reviewed Published Full-Length Conference Papers

1. Yalçın, M. A., Elmqvist, N., & **Bederson, B. B.*** (2017) Raising the Bars: Evaluating Treemaps vs. Wrapped Bars for Dense Visualization of Sorted Numeric Data, *Proceedings of Graphics Interface (GI 2017)*, 41-49. DOI: https://doi.org/10.20380/GI2017.06

2. Quinn, A., & **Bederson, B. B.*** (2014) AskSheet: Efficient Use of Web Workers to Support Decision Making, *Proceedings of ACM CSCW (CSCW 2014)*, ACM Press, pp. 1456–1466.

3. Yeh, T., Chang, T-H., Xie, B., Walsh, G., Watkins, I., Wongsuphasawat, K., Davis, L.S., & **Bederson, B. B.*** (2011) Creating Contextual Help for GUIs Using Screenshots, *Proceedings of ACM UIST (UIST 2011)*, ACM Press, 145-154.

4. Quinn, A., & **Bederson, B. B.*** (2011) Human Computation: A Survey and Taxonomy of a Growing Field, *Proceedings of ACM CHI (CHI 2011)*, ACM Press, 1403-1412.

5. Resnik, P., Buzek, O., Hu, C., Kronrod, Y., Quinn, A.J., & **Bederson, B. B.*** (2010) Improving Translation via Targeted Paraphrasing, *Proceedings of Conference on Empirical Methods in Natural Language Processing (EMNLP 2010)*, 127-137.

6. Hu, C., **Bederson, B. B.,** & Resnik, P. (2010) Translation by Interactive Collaboration between Monolingual Users, *Proceedings of Graphics Interface (GI 2010),* 39-46.

7. Dearman, D., Karlson, A., Meyers, B., & **Bederson, B. B.** (2010) Multi-Modal Text Entry and Selection on Mobile Devices, *Proceedings of Graphics Interface (GI 2010),* 19-26.

8. Quinn, A., Hu, C., Arisaka, T., & **Bederson, B. B.*** (2008) Readability of Scanned Books in Digital Libraries, *Proceedings of ACM CHI (CHI 2008)*, ACM Press, 705-714. [22% acceptance rate]

9. Karlson, A., & **Bederson, B. B.*** (2008) One-Handed Touchscreen Input for Legacy Applications, *Proceedings of ACM CHI (CHI 2008)*, ACM Press 1399-1408. [22% acceptance rate]

10. **Bederson, B. B.**, Clamage, A., Plaisant, C., (2008) Enhancing In-Car Navigation Systems with Personal Experience, *in Proc. of the Transportation Research Board 87th annual meeting*, The National Academies, Washington, DC (2008) 1-11.

11. Karlson, A., & **Bederson, B. B.*** (2007) ThumbSpace: Generalized One-Handed Input for Touchscreen-Based Mobile Devices, *Proceedings of INTERACT 2007*, 324-338 – **Winner of Brian Shackel Award for making an "outstanding contribution with international impact in the field of HCI".**

12. Druin, A., Weeks, A., Massey, S., & **Bederson, B. B.** (2007) Children's Interests and Concerns When Using the International Children's Digital Library: A four country case study, *Proceedings of the Joint Conference on Digital Libraries (JCDL 2007)*, 167-176. – **Nominated for Best Paper Award, came in #2.** [36% acceptance rate].

13. Parhi, P., Karlson, A., & **Bederson, B. B.*** (2006). "Target Size Study for One-Handed Thumb Use on Small Touchscreen Devices", *Proceedings of MobileHCI 2006*, ACM Press, 203-210. – **Winner of Best Historical Paper Award, September 2016.**

14. Hutchinson, H. B., **Bederson, B. B.**, & Druin, A. (2006). "The Evolution of the International Children's Digital Library Searching and Browsing Interface", *Proceedings of 5th International Conference for Interaction Design and Children (IDC 2006)*, ACM Press, 105-112. [38% acceptance rate]

15. Hutchinson, H., Druin, A., **Bederson, B. B.**, Reuter, K., Rose, A., Weeks, A. (2005) How do I Find Blue Books About Dogs? The Errors and Frustrations of Young Digital Library Users, *Proceedings of HCII 2005*, Las Vegas, NV (CD-ROM).

16. Shneiderman, B. & **Bederson, B. B.** (2005). "Maintaining Concentration to Achieve Task Completion", *Proceedings of Designing User Experience (DUX 2005)*.

17. Karlson, A., **Bederson, B. B.**, & SanGiovanni, J. (2005). AppLens and LaunchTile: Two Designs for One-Handed Thumb Use on Small Devices, CHI Letters, 7(1), 201-210. [25% acceptance rate] – **Nominated for Best Paper Award.**

18. Khella, A., **Bederson, B. B.*** (2004). Pocket PhotoMesa: A Zoomable Image Browser for PDAs. *In Proceedings of Mobile and Ubiquitous Multimedia (MUM 2004)* ACM Press, 19-24.

19. Lee, B., Parr, C. S., Campbell, D., & **Bederson, B. B.*** (2004). How Users Interact With Biodiversity Information Using TaxonTree. *In Proceedings of Advanced Visual Interfaces (AVI 2004)* ACM Press, 320-327. [25% acceptance rate]

20. Suh, B., Ling, H., **Bederson, B. B.**, & Jacobs, J. W. (2003). Automatic Thumbnail Cropping and Its Effectiveness. UIST 2003, ACM Symposium on User Interface Software and Technology, CHI Letters, 5(2), 95-104. [22% acceptance rate] – **Winner of Best Student Paper Award**.

21. **Bederson, B. B.**, Lee, B., Sherman, R., Herrnson, P. S., Niemi, R. G. (2003). Electronic Voting System Usability Issues. CHI 2003, ACM Conference on Human Factors in Computing Systems, CHI Letters, 5(1), 145-152. [16% acceptance rate]

22. Hutchinson, H., Mackay, W., Westerlund, B., **Bederson, B. B.**, Druin, A., Plaisant, C., Evans, H., Hansen, H., Conversy, S., Beaudouin-Lafon, M., Roussel, N., Lacomme, L., Eiderbäck, B., Lindquist, S., Sundblad, Y. (2003). Technology Probes: Inspiring Design for and with Families. CHI 2003, ACM Conference on Human Factors in Computing Systems, CHI Letters, 5(1), 17-24. [16% acceptance rate]

23. Knudtzon, K., Druin, A., Kaplan, N., Summers, K., Chisik, Y., Kulkarni, R., Moulthrop, S., Weeks, H., & **Bederson, B.** Starting an Intergenerational Technology Design Team: A Case Study. *In Proceedings of* Interaction Design and Chidlren (*IDC 2003*) ACM Press, 51-58.

24. Baudisch, P., Cutrell, P., Robbins, D., Czerwinski, M., Tandler, P., **Bederson, B. B.**, & Zierlinger, A. (2003) Drag-and-Pop and Drag-and-Pick: Techniques for Accessing Remote Screen Content on Touch- and Pen-Operated Systems. *Proceedings of Interact 2003*, Austria: International Federation for Information Processing, 57-64. [33% acceptance rate]

25. Plaisant, C., Grosjean, J., & **Bederson, B. B.*** (2002) SpaceTree: Design Evolution of a Node Link Tree Browser. *Proceedings of Information Visualization Symposium (InfoVis 2002)* New York: IEEE, 57-64. [27% acceptance rate] – **Won 2022 IEEE Vis Test of Time Award in InfoVis, https://ieeevis.org/year/2022/info/awards/test-of-time-awards.**

26. Suh, B., & **Bederson, B. B.*** (2002) OZONE: A Zoomable Interface for Navigating Ontology Information. *Proceedings of International Conference on Advanced Visual Interfaces (AVI 2002)*, ACM Press, Trento, Italy, 139-143. [30% acceptance rate]

27. Boltman, A., Druin, A., **Bederson, B.**, Hourcade, J.P., Stanton, D., O'Malley, C., Cobb, S., Benford, S., Fast, C., Kjellin, M., & Sundblad, Y. (2002). The nature of children's storytelling with and without technology. *Proceedings of American Educational Research Association (AERA) Conference*, New Orleans.

28. **Bederson, B. B.** (2001). PhotoMesa: A Zoomable Image Browser Using Quantum Treemaps and Bubblemaps. UIST 2001, ACM Symposium on User Interface Software and Technology, CHI Letters, 3(2), 71-80. [19% acceptance rate]

29. Druin, A., **Bederson, B. B.**, Hourcade, J.P., Sherman, L., Revelle, G., Platner, M., Weng, S. (2001) Designing a Digital Library for Young Children. *In Proceedings of Joint Conference on Digital Libraries (JCDL 2001)* ACM Press, 398-405. [30% acceptance rate]

30. Benford, S., **Bederson, B. B.**, Åkesson, K., Bayon, V., Druin, A., Hansson, P., Hourcade, J. P., Ingram, R., Neale, H., O'Malley, C., Simsarian, K., Stanton, D., Sundblad, Y., & Taxén, G. (2000). Designing Storytelling Technologies to Encourage Collaboration Between Young Children. CHI 2000, ACM Conference on Human Factors in Computing Systems, CHI Letters, 2(1), 556-563. [19% acceptance rate]

31. **Bederson, B. B.**, Meyer, J., & Good, L. (2000). Jazz: An Extensible Zoomable User Interface Graphics Toolkit in Java. UIST 2000, ACM Symposium on User Interface Software and Technology, CHI Letters, 2(2), 171-180. [26% acceptance rate]

32. **Bederson, B. B.** (2000). Fisheye Menus. UIST 2000, ACM Symposium on User Interface Software and Technology, CHI Letters, 2(2), 217-225. [26% acceptance rate]

33. Gandhi, R., Kumar, G., **Bederson, B. B.**, & Shneiderman, B. (2000). Domain Name Based Visualization of Web Histories in a Zoomable User Interface. *In Proceedings of Eleventh International Workshop on Database and Expert Systems Applications – Second International Workshop on Web-Based Information Visualization (WebVis 2000)*, IEEE Computer Society, Los Alamitos, CA (2000), 591-598.

34. **Bederson, B. B.**, & Boltman, A. (1999). Does Animation Help Users Build Mental Maps of Spatial Information? *In Proceedings of Information Visualization Symposium (InfoVis 99)* New York: IEEE, 28-35. [23% acceptance rate]

35. Combs, T. T. A., & **Bederson, B. B.*** (1999). Does Zooming Improve Image Browsing? *In Proceedings of Digital Library (DL 99)* New York: ACM, 130-137. [21% acceptance rate]

36. Stewart, J., **Bederson, B. B.**, & Druin, A. (1999). Single Display Groupware: A Model for Co-Present Collaboration. *In Proceedings of Human Factors in Computing Systems (CHI 99)* ACM Press, 286-293. [25% acceptance rate]

37. Hightower, R. R., Ring, L., Helfman, J., **Bederson, B. B.**, & Hollan, J. D. (1998). Graphical Multiscale Web Histories: A Study of PadPrints. *In Proceedings of ACM Conference on Hypertext (Hypertext 98)* ACM Press, 58-65.

38. Druin, A., Stewart, J., Proft, D., **Bederson, B. B.**, & Hollan, J. D. (1997). KidPad: A Design Collaboration Between Children, Technologists, and Educators. *In Proceedings of Human Factors in Computing Systems (CHI 97)* ACM Press, 463-470. [22% acceptance rate]

39. **Bederson, B. B.**, Hollan, J. D., Stewart, J., Rogers, D., Druin, A., & Vick, D. (1996). A Zooming Web Browser. *In Proceedings of SPIE Multimedia Computing and Networking* New York: IEEE, 260-271. https://www.spiedigitallibrary.org/conference-proceedings-of-spie/2667/0000/Zooming-Web-browser/10.1117/12.235898.short

40. **Bederson, B. B.**, & Hollan, J. D. (1995). Advances in the Pad++ Zoomable Graphics Widget. *In Proceedings of USENIX Tcl/Tk '95 Workshop (Tcl/Tk 95)* New York: USENIX, 3.

41. Furnas, G. W., & **Bederson, B. B.** (1995). Space-Scale Diagrams: Understanding Multiscale Interfaces. *In Proc. of Human Factors in Computing Systems (CHI 95)* ACM Press, 234-241. [29% acceptance rate]

42. **Bederson, B. B.**, & Hollan, J. D. (1994). Pad++: A Zooming Graphical Interface for Exploring Alternate Interface Physics. *In Proc. of User Interface and Software Technology (UIST 94)* ACM Press, 17-26.

43. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (1993). Control & Design of the Spherical Pointing Motor. *In Proceedings of IEEE International Conference on Robotics and Automation (ICRA 93)* New York: IEEE, 2, 630-636.

44. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (1992). A Miniaturized Active Vision System. *In Proceedings of Eleventh International Conference on Pattern Recognition,* IEEE Press, 58-61.

45. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (1992). Two Miniature Pan-Tilt Devices. *In Proceedings of IEEE International Conference on Robotics and Automation,* New York: IEEE Press, (1), 658-663.

46. Wallace, R. S., **Bederson, B. B.**, & Schwartz, E. L. (1992). Voice-Bandwidth Visual Communication Through Logmaps: the Telecortex. *In Proceedings of IEEE Workshop on Applications of Computer Vision* New York: IEEE Press, 4-10.

iii. Other Publications

1. Yalcin, M. A., Elmqvist, N., & **Bederson, B. B.*** (2017). Piled Bars: Dense Visualization of Numeric Data. Poster presented at Graphics Interfaces, 2017.

2. **Bederson, B. B.**, Barker, K., Owens, L., Kim, Y. J. & Palmer, K. (2017) Designing Organizations to Support Tech on Campus. Panel at SXSW Edu, Austin, TX, March 6, 2017.

3. Yalcin, M. A., Elmqvist, N., & **Bederson, B. B.*** (2016). Keshif: Out-of-the-Box Visual and Interactive Data Exploration Environment. In *Proceedings of IEEE VIS 2016 Workshop on Visualization in Practice: Open Source Visualization and Visual Analytics Software*.

4. Yalcin, M. A., Elmqvist, N., & **Bederson, B. B.*** (2016). Cognitive Stages in Visual Data Exploration. In *Proceedings of Beyond Time and Errors: Novel Evaluation Methods for Visualization* (BELIV 2016) at IEEE VIS 2016.

5. Roberts, S., Swan, L., & **Bederson, B. B.** (2016). "Fishing for Faculty: The Bait and Hooks", Workshop in 2016 Professional and Organizational Development (POD) Conference, Louisville, KY, November, 2016.

6. Anderson, L. B., Gardner, E. E., Wolvin, A., Kirby-Straker, R., Yalcin, A., & **Bederson, B. B.*** (2015), "Incorporating Learning Analytics into Basic Course Administration: How to Embrace the Opportunity to Identify Inconsistencies and Inform Responses". *In NCA 2015 - 101th Annual meeting of the National Communication Association*. **Top Paper in Basic Course Division.**

7. Anderson, L. B., Gardner, E. E., Wolvin, A., Kirby-Straker, R., Yalcin, A., & **Bederson, B. B.*** (2015), "Utilizing learning analytics to improve the basic course: A qualitative analysis of the instructor feedback captured in Revealer". *Paper presented at the annual meeting of the Eastern Communication Association, Philadelphia, PA, June 2015*.

8. Hara, K, Hajiaghayi, M., & **Bederson, B. B.** (2015). FluTCHA: Using Fluency to Distinguish Humans from Computers, short paper and poster, WWW2015, Florence, Italy, May 18-22, 2015.

9. Teasley, S., & **Bederson, B. B.** (2015). Learning Analytics and iSchools: What, Why & Worries, *at iConference*, Session for Interaction and Engagement, March 24-27, 2015, Newport Beach, CA.

10. Xu, Z., Goldwasser, D., **Bederson, B. B.**, Lin, J. (2014) Visual Analytics of MOOCs at Maryland, *Poster at Learning @ Scale Conference (L@S '14)*.

11. **Bederson, B. B.**, Jin, G., Leslie, P., Quinn, A.J., & Zhou, B. (alphabetical order), (2014) "Incomplete Disclosure: Insights from Maricopa", International Industrial Organization Conference, April 11-13, 2014, Chicago.

12. Lee, T.Y., Mauriello, M.L., Ingraham, J., Sopan, A., Ahn, J., & **Bederson, B. B.*** (2012) "CTArcade: Learning Computational Thinking while Training Virtual Characters Through Game Play", WiP at CHI 2012, ACM Press, 2309-2314.

13. Cranor, L., **Bederson, B. B.**, & Quesenberry, W. (2012) "Occupy CHI! Engaging U.S. Policymakers", Panel in CHI 2012, ACM Press, 1139-1142.

14. **Bederson, B. B.**, Quinn, A. J., & Rose, A. (2012) SearchParty: Learning to Search in a Web-based Classroom, Workshop paper at CHI 2012.

15. Hu, C., Resnik, P., Kronrod, Y., & **Bederson, B. B.*** (2012) Deploying MonoTrans Widgets in the Wild. Note at CHI 2012, ACM Press, 2935-2938.

16. Hu, C., Resnik, P., Kronrod, Y., Eidelman, V., Buzek, O., & **Bederson, B. B.*** (2011) The Value of Monolingual Crowdsourcing in a Real-World Translation Scenario: Simulation using Haitian Creole Emergency SMS Messages. *In Proceedings of EMNLP 2011 Sixth Workshop on Statistical Machine Translation, 399-404.*

17. Kronrad, Y., Hu, C., Buzek, O., & Quinn, A.J. (2011) Using Monolingual Crowd to Improve Translation. Student poster at AAAS 2011. **Winner of poster in Math, Technology and Engineering category.**

18. **Bederson, B. B.**, & Quinn, A.J. (2011) Web Workers Unite! Addressing Challenges of Online Laborers. Alt.CHI paper at CHI 2011, ACM Press, 97-106.

19. Hu, C., **Bederson, B. B.**, & Resnik, P. (2011) MonoTrans2: A New Human Computation System to Support Monolingual Translation. Short paper at CHI 2011, ACM Press, 1133-1136.

20. Kronrod, Y., Buzek, O., Hu, C., Quinn, A., Resnik, P., & **Bederson, B. B.*** (2010) Using Crowdsourcing to Translate Without Bilinguals. Poster at CrowdConf 2010.

21. Hu, C., **Bederson, B. B.**, and Resnik, P. (2010) Translation by Iterative Collaboration Between Monolingual Users. Abstract and demo at the Human Computation Workshop (HCOMP 2010), 54-55.

22. Buzek, O., Resnik, P., & **Bederson, B. B.*** (2010) Error Driven Paraphrase Annotation using Mechanical Turk, In Creating Speech and Language Data With Amazon's Mechanical Turk, NAACL 2010 Workshop, 2010.

23. Chen, R., Rose, A., & **Bederson, B. B.*** (2009) How People Read Books Online: Mining and Visualizing Web Logs for Use Information. In Proceedings of European Conference on Digital Libraries (ECDL 2009), Short Paper, 364-369.

24. **Bederson, B. B.**, Rutledge, P., Quinn, A. (2009) Generalizing the International Children's Digital Library. In Proceedings of the Digital Humanities Conference (DH 09), Poster.

25. **Bederson, B. B.**, Quinn, A., Druin, A. (2009) Designing the Reading Experience for Scanned Multi-lingual Picture Books on Mobile Phones. In Proceedings of the Joint Conference on Digital Libraries (JCDL 2009), Short Paper, ACM Press, New York, NY, 305-308.

26. Hu, C., Rose, A., **Bederson, B. B.*** (2009) Locating Text in Scanned Books. In Proceedings of the Joint Conference on Digital Libraries (JCDL 2009), Poster.

27. Druin, A., Cavallo, D., Fabian, C., **Bederson, B. B.**, Revelle, G., Rogers, Y. (2009) Mobile Technologies for the World's Children. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2009), ACM Press, Panel.

28. **Bederson, B. B.** (2008) "Experiencing the International Children's Digital Library", Interactions Magazine, ACM Press, 15 (6), 50-54.

29. Lazar, J., Hochheiser, H., Johnson, J., Karat, C-M., **Bederson, B. B.** (2008) "CHI Policy Issues Around the World", Panel in CHI 2008, ACM Press, 2277-2280.

30. Teevan, J., Jones, W., **Bederson, B. B.**, (2006) "Introduction: Personal Information Management," Communications of the ACM, 49 (1), 40-43. Ranked #3 "Year Rank" in annual downloads among ACM Magazines and Computing Surveys articles (CACM, 50 (12), 92-93).

31. Lee, B., Parr, C.S., Plaisant, C., **Bederson, B. B.**, (2006) "TreePlus: Visualizing Graphs as Trees," Video in InfoVis 2006.

32. Herrnson, P.S., Niemi, R.G., Hanmer, M.J., **Bederson, B. B.**, Conrad, F.G., Traugott, M., (2006) "The Importance of Usability Testing of Voting Systems," in Usenix/Accurate Electronic Voting Workshop.

33. Herrnson, P., Niemi, R., Hanmer, M., **Bederson, B. B.**, Conrad, F., Traugott, M., (2006) "Voter Errors in Electronic voting: Voting Systems, Ballot Type, and Voter Traits," In Midwest Political Science Association annual conference.

34. Herrnson, P., Niemi, R., Hanmer, M., **Bederson, B. B.**, Conrad, F., Traugott, M., (2006) "Voters' Abilities to Cast Write-In Votes Using Electronic Voting Systems," In Midwest Political Science Association annual conference.

35. Conrad, F., Peytcheva, E., Traugott, M., Lewis, B., Herrnson, P., **Bederson, B. B.** (2006) "Usability of Electronic Voting Systems: Field and Laboratory Experiments," In Midwest Political Science Association annual conference.

36. Lee, B., Parr, C. S., Plaisant, C., & **Bederson, B. B.*** (2005) "Visualizing Graphs as Trees: Plant a Seed and Watch it Grow", Proceedings of Graph Drawing 2005, 516-518.

37. Klein, C. &, **Bederson, B. B.*** (2005). "Benefits of Animated Scrolling", Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2005) ACM Press, Short Paper, 1965-1968.

38. Lee, B., Czerwinski, M., Robertson, G. G. &, **Bederson, B. B.** (2005). "Understanding Research Trends in Conferences using PaperLens", Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2005) ACM Press, Short Paper, 1969-1972.

39. Traugott, M.W., Hanmer, M.J., Park, W.H., Herrnson, P.S., Niemi, R.G., **Bederson, B. B.**, Conrad, F.G.,(2005) "The Impact of Voting Systems on Residual Votes, Incomplete Ballots, and Other Measures of Voting Behavior," In American Political Science Association meeting (APSA 2005).

40. Lee, B., Czerwinski, M., Robertson, G. G. &, **Bederson, B. B.** (2004). "Understanding Eight Years of InfoVis Conferences using PaperLens", InfoVis 2004 Symposium Compendium. **Winner of InfoVis Contest**.

41. **Bederson, B. B.** (2004) Interfaces for Staying in the Flow. In Ubiquity, ACM Press, (5) 27.

42. Hourcade, J. P., **Bederson, B. B.**, Druin, A. (2004) Preschool Children's Use of Mouse Buttons. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2004) ACM Press, Short Paper, 1411-1412.

43. Selker, T., Fischer, E. A., **Bederson, B. B.**, McCormack, C., Nass, C. (2003) Voting: User Experience, Technology and Practice. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2003) ACM Press, Panel, 700-701.

44. **Bederson, B. B.**, Clamage, A., Czerwinski, M. P., Robertson, G. G. (2003) A Fisheye Calendar Interface for PDAs: Providing Overviews in Small Displays. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2003) ACM Press, Demonstration, 618-619.

45. Hourcade, J.P., **Bederson, B. B.**, Druin, A., Rose, A., Farber, A., Takayama, Y. (2002). The International Children's Digital Library: Viewing Digital Books Online. Interaction Design and Children International Workshop, August 28-29, 2002, Eindhoven, The Netherlands 15 (3), 151-167.

46. Herrnson, P., **Bederson, B. B.** (2002) Debugging Maryland Balloting, Washington Post, Outlook Section, p. B08, Sunday May 12th, 2002.

47. Good, L., **Bederson, B. B.**, Stefik, M., Baudisch, P. (2002) Automatic Text Reduction For Changing Size Constraints. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2002) ACM Press, Short Paper, 798-799.

48. Hourcade, J.P., **Bederson, B. B.**, Druin, A., Taxén, G. (2002) KidPad: A Collaborative Storytelling Tool for Children. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2002) ACM Press, Referred Demo, 500-501.

49. Hourcade, J.P., **Bederson, B. B.**, Druin, A. (2002) SearchKids: A Digital Library Interface for Young Children. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 2002) ACM Press, Referred Demo, 512-513.

50. **Bederson, B. B.** (2001). PhotoMesa: A Zoomable Image Browser Using Quantum Treemaps and Bubblemaps. UIST 2001, ACM Symposium on User Interface Software and Technology. Refereed demo.

51. Browne, H., **Bederson, B. B.**, Druin, A., Sherman, L., & Westerman, W. (September 2000) Designing a Collaborative Finger Painting Application for Children, HCIL-2000-17, CS-TR-4184, UMIACS-TR-2000-66

52. Hourcade, J., **Bederson, B. B.** (May 1999) Architecture and Implementation of a Java Package for Multiple Input Devices (MID) HCIL-99-08, CS-TR-4018, UMIACS-TR-99-26

53. Hightower, R.R., Ring, L.T., Helfman, J.I., **Bederson, B. B.**, Hollan, J.D. (1998) PadPrints: Graphical Multiscale Web Histories. UIST 1998, ACM Symposium on User Interface Software and Technology. Tech Note, 121-122.

54. Stewart, J., Raybourn, E., **Bederson, B. B.**, & Druin, A. (1998). When Two Hands Are Better Than One: Enhancing Collaboration Using Single Display Groupware. In Proceedings of Extended Abstracts of Human Factors in Computing Systems (CHI 98) ACM Press, Short Paper, 287-288.

55. **Bederson, B. B.**, Hollan, J. D., Druin, A., Stewart, J., Rogers, D., & Proft, D. (1996). Local Tools: An Alternative to Tool Palettes. In Proceedings of User Interface and Software Technology (UIST 96) ACM Press, Short Paper, 169-170.

56. **Bederson, B. B.**, Hollan, J. D. (1995) Pad++: A Zoomable Graphical Interface System. In Proceedings of Conference on Human Factors in Computing Systems Conference Companion (CHI 95) ACM Press, Short Paper, 23-24.

57. **Bederson, B. B.**, & Davenport, G., & Druin, A., & Maes, P. (1994). Immersive Environments: A Physical Approach to the Multimedia Experience, In Proceedings of IEEE International Conference on Multimedia Computing and Systems, Boston, Massachusetts, May 17-19, 1994, (Panel).

58. **Bederson, B. B.** (1995). Audio Augmented Reality: A Prototype Automated Tour Guide. In Proceedings of Human Factors in Computing Systems (CHI 95) New York: ACM Press, (Short Paper), 210-211.

59. Stone, L. M., Erickson, T., **Bederson, B. B.**, Rothman, P., Muzzy, R. (1994) Visualizing Data: Is Virtual Reality the Key? IEEE Visualization, IEEE Press, Short Paper, 410-413.

60. **Bederson, B. B.**, Stead, L., & Hollan, J. D. (1994). Pad++: Advances in Multiscale Interfaces. In Proceedings of Human Factors in Computing Systems (CHI 94) New York: ACM Press, Short Paper, 315-316.

61. **Bederson, B. B.** (1992). A Miniature Space-Variant Active Vision System: Cortex-I. Doctoral dissertation, New York University, New York, NY.

E. TALKS, ABSTRACTS, AND OTHER PROFESSIONAL PAPERS PRESENTED
i. Keynote Talks

1. April 2017 **CHIuXiD - The International Conference in Human-Computer Interaction & User Experience**, Jakarta, Indonesia
   "From Human-Computer Interaction to Strategic Leadership for Change"
2. March 2017 **Maryland College Learning Center Association**, Shady Grove, MD
   "Fishing for Faculty: Teaching & Learning Engagement at UMD"
3. April 2014 **Innovations in Teaching and Learning Conference**, College Park, MD
   "An Introduction to the Teaching and Learning Transformation Center"

4. October, 2012 **South African Institute for Computer Scientists and Information Technologists** Johannesburg, South Africa
   "Social Participation: How Collective Activity Can Make Change"
5. September, 2010 **Visual Information Communication International Symposium**, Beijing, China
   "The Promise of Zoomable User Interfaces"
6. May, 2010 **Human-Computer Interaction Lab's 27th Annual Symposium**, College Park, MD
   "The Promise of Zoomable User Interfaces"
7. November, 2009 Raja Roy Singh Keynote Lecture at the **UNESCO Asia-Pacific Programme of Educational Innovation for Development**, Hangzhou. China
   "Educational Technology for Creativity, Collaboration and Community"
8. February, 2009 **Microsoft Internal "UX Canvas Camp"**, Redmond, WA
   "A Short History of Zoomable User Interfaces"
9. September, 2002 **IEEE Symposium on Human Centric Computing Languages and Environments (HCC 02)**, Arlington, VA
   "Interfaces for Staying in the Flow"

ii. Invited Talks (doesn't include Keynote talks, which are listed above)

1. October 3, 2018, **Rutgers University**, Newark, NJ
   "Transforming Teaching at the University of Maryland"
2. September 28, 2018, **EPAM Executive Roundtable**, Minsk, Belarus
   "Workforce of the Future"
   on Panel with Eugene Roman (Canada Tire), Sjoerd Gehring (Johnson & Johnson) & Sandra Loughlin (UMD)
3. September 27, 2018, **EPAM Software Engineering Conference (SEC 2018)**, Minsk, Belarus
   "Open Company, Open Community, Open World"
   on Panel with Elaina Shekhter (EPAM), Sjoerd Gehring (Johnson & Johnson), Scott Nissenbaum (Ben Franklin Technology Partners) & Sandra Loughlin (UMD)
4. December 4, 2017, **Cornell Tech**, New York, NY
   "Academic Technologies in Higher Ed"
5. November 10, 2017, **Online Programs and MOOCs – Opportunities and Challenges**, in The 7th Annual MIS Academic Leadership Conference, RHSmith School of Business, University of Maryland
6. Sept 2, 2017, **Google**, New York, NY
   "Academic Technologies in Higher Ed"
7. June 11, 2015 **Designing a Learning Environment**, in "Open Textbooks: Challenges for Policy" workshop, University of Haifa, Haifa, Israel
8. May 13, 2015 **Strategic Integration of MOOCs into Graduate and Professional STEM Programs**, Champaign, Illinois
   Raineri, D., Breslow, L., **Bederson, B. B.**
   "Future of MOOCs in Research Universities"
9. April 13, 2015 **#EduAnalyticsDC Workshop**, Washington, DC
   "Understanding Consistency in a Large Multi-Section Course with Many Instructors"
10. March 3, 2015 **Coursera Partners Conference**, Newport Beach, CA
    Verstelle, M., Bennett, A., **Bederson, B. B.**, & Jeffries, Pam
    "Designing a MOOC Portfolio: Content Strategy for Online Education"
11. March 1, 2015 **Coursera Partners Conference**, Newport Beach, CA
    Buitendijk, S., **Bederson, B. B.**, Kerrison, M., & Price, V.
    "Value to Partners: Case Studies From Partner Institutions"

12. January 29, 2015 **University of Wisconsin, Madison**, Madison, WI
"Reflections on 20 Years Doing HCI Systems Research"
Department of Computer Science, Distinguished Lecture Series

13. Sheil, M., Rock, E., O'Brien, L., **Bederson, B. B.**, & Xiaoming, L. (2014) "Future Trajectories of MOOCS in Higher Ed", Panel at Coursera Partners' Conference.

14. February 12, 2014 **Patuxent Partnership**, Lexington Park, MD
"UMD MOOCs and What the Future Holds For Them"

15. January 29, 2014 **Carnegie Mellon University**, Pittsburgh, PA
"Power to the People: Approaches to Crowdsourcing"

16. January 14, 2014 **Microsoft**, Friendship Heights, MD
"Cracking the Code: Improving Computer Science Education Outcomes in the State of Maryland"
Panel participant on Microsoft public series "Conversations on Education"

17. November 20, 2013 **University of Maryland**, College Park, MD
"Mobile, Online, Flipped, Active: New Uses of Educational Technologies"
College of Education

18. October 11, 2013 **Huawei**, Hong Kong, China
"When Crowds Come Together"

19. October 8, 2013 **National Institute of Information and Communications Tecnology**, Osaka, Japan
"Crowdsourced Monolingual Translation"
in 2nd Workshop on Future Directions in Translation Research

20. February 1, 2013 **Google**, Mountain View, CA
"Social + MOOCs + Hcomp = SMOOCH: Computing Comes to Education"

21. January 29, 2013 **Google**, Mountain View, CA
"The Promise of Zoomable User Interfaces: Reflections on Design of Simple UX"

22. December 6, 2012 **Sunlight Foundation**, Washington, DC
"Digital Disclosure of a Nationally Standardized Database of Restaurant Food Safety Inspections" (with Ginger Jin)

23. November 19, 2012 **University of Maryland**, College Park, MD
"Innovation, Iteration & Creation: A Discussion about the Development of New Ideas in the Modern World"

24. November 6, 2012 **World Usability Day**, Minsk, Belarus
"The Promise of Zoomable User Interfaces"

25. November 2, 2012 **Central & Eastern European Software Engineering Conference in Russia** Moscow, Russia
"Learning to Code in an Online World"

26. November 2, 2012 **Central & Eastern European Software Engineering Conference in Russia** Moscow, Russia
Panelist in "Peopleware: what skills and qualifications we need to build a dream team of software engineers"

27. October 4, 2012 **UNISA – University of South Africa**, Johannesburg, South Africa
"Innovation, Iteration & Creation: A Discussion about the Development of New Ideas in the Modern World"

28. June 20, 2012 **University of Haifa**, Haifa, Israel
"Books that are Blue: What Children Can Teach Us About Creating New Technologies" (with Allison Druin)

29. June 19, 2012 **Interdisciplinary Center**, Herzilya, Israel
"Books that are Blue: What Children Can Teach Us About Creating New Technologies" (with Allison Druin)

30. Nov 17, 2011 **Future of Information Alliance**, College Park, MD
"Anonymity and Privacy While Learning"

31. Sept 21, 2011 **U.S. Senate and Congress Briefings**, Washington, DC
Panel participant in "Deconstructing the iPad: How Federally Supported Research Leads to Game-Changing Innovation" run by the Task Force on American Innovation and the CRA

32. Aug 24, 2011 **Summer Social Webshop** College Park, MD
"Translation by Collaboration Among Monolingual Users"

33. May, 2011 **National Science Foundation**, Arlington, VA
Distinguished Lecture Series
"Translation by Collaboration among Monolingual Users" (with Philip Resnik)

34. September, 2010 **Microsoft Research Asia**, Beijing, China
"Collaborative Monolingual Translation"

35. September, 2010 **Tsinghua University**, Beijing, China
"Collaborative Monolingual Translation"

36. April, 2010 **CHI 2010**, Atlanta, GA
Social Impact Award talk

37. October, 2009 **Google**, Mountain View, CA
Panel participant in "Breakthrough Learning in a Digital Age" invitation only conference

38. September, 2009 **Google Tech Talk**, Mountain View, CA
"Translation by Iterative Collaboration between Monolingual Users"

39. April, 2009 **University of Illinois (CS Dept.)**, Champaign-Urbana, IL
"Zoomable User Interfaces from Sun Sparcstations to iPhones"

40. April, 2009 **University of Illinois (iSchool)**, Champaign-Urbana, IL
"From Ulann Baatar to iPhone: A Digital Library for the World's Children"

41. February, 2009 **Tufts University**, Medford, MA
"From iPhone to Ulaan Baatar: A Digital Library for the World's Children"

42. February, 2009 **Microsoft Internal "UX Canvas Camp"**, Redmond, WA
"A Short History of Zoomable User Interfaces"

43. September, 2008, **Carnegie Mellon University**, Pittsburgh, PA
"Black Ears to Blonde Cats: Paths for Designing Change"

44. May, 2008, **Manchester Public Library** Manchester by the Sea, MA
"No Road, Drive: The ICDL Travels to Mongolia"

45. April, 2008 **Web 2.0 Expo**, San Francisco, CA
"Next Generation Mobile UI" (with John SanGiovanni)

46. February, 2008 **USACM Executive Council**, Washington, DC
"Voting Technology: The Not-So-Simple Act of Casting a Ballot"

47. October, 2007 **Widget Summit**, San Francisco, CA
"Mobile Widget Design"

48. September, 2007 **Knight Center for Specialized Journalism**, College Park, MD
"Mobile Technology Trends"

49. June, 2007 **Mobile Marketing Association**, New York, NY
"Designing for Usability"

50. May, 2007 **MIT Enterprise Forum**, Arlington, VA
"Co-present Mobile Collaboration"

51. December, 2006 **Human Factors and Ergonomics Society Potomac Chapter**, Bethesda, MD
"A Library for the World's Children"

52. June, 2006 **Open Society Forum**, Ulaan Baatar, Mongolia
"A Library for the World's Children"

53. February, 2006 **Dingman Center for Entrepreneurship, R.H. Smith School of Business**, UMD
"Web 2.0 UI"

54. December, 2005 **World Bank**, Washington, DC
"The International Children's Digital Library"

55. December, 2005 **IBM T.J. Watson Research Center**, Hawthorne, NY
"Making Visualization Work"

56. November, 2005 **NSA**, Laurel, MD
"Making Visualization Work"

57. October, 2005 **IBM Research**, Cambridge, MA
"Making Visualization Work"

58. October, 2005 **Johns Hopkins University – Computer Science Dept.**, Baltimore, MD
"Making Visualization Work"

59. September, 2005 **InfoToday Conference on 'Innovations in Search'**, New York, NY
"Zooming Into Visual Search"

60. March, 2005 **NFAIS**, Philadelphia, PA
"Making Sense of Search Results"

61. February, 2005 **American Association for the Advancement of Science (AAAS)** Washington, DC
Panel in annual conference,
"Designing Interfaces for Voting Machines"

62. February, 2005 **National Association of State Election Directors (NASED)** Washington, DC
Invited talk at annual conference.
"Designing Interfaces for Voting Machines"

63. January, 2005 **Microsoft**, Seattle, WA
"Interfaces for Staying in the Flow"

64. January, 2005 **Google**, Mountain View, CA
"The International Children's Digital Library"

65. December, 2004 **National Library of New Zealand,** Wellington, New Zealand
"The International Children's Digital Library"

66. December, 2004 **University of Waikato**, Hamilton, New Zealand
"Interfaces for Staying in the Flow"

67. December, 2004 **Victoria University Wellington**, Wellington, New Zealand
"Interfaces for Staying in the Flow"

68. December, 2004 **University of Canterbury**, Christchurch, New Zealand
"Interfaces for Staying in the Flow"

69. November, 2004 **National Archives and Records Administration (NARA)**, College Park, MD
in Conference "Partnerships in Innovation: Serving a Networked Nation"
"International Children's Digital Library"

70. April, 2004 **Johns Hopkins University Applied Physics Lab**, Laurel, MD
"Interfaces for Staying in the Flow"

71. October, 2003 **University of Maryland, Robert H. Smith School of Business**, College Park, MD
on InForum 2003 panel on "Does IT Matter?"

72. September, 2003 **University of Maryland**, College Park, MD
"Making Visualization Work"

73. September, 2003 **University of Victoria**, Victoria, Canada
"Interfaces for Staying in the Flow"

74. March, 2003 **National Archives and Records Administration**, College Park, MD
”Visualizations for Archivists”

75. March, 2003 **Microsoft Research**, Redmond, WA
”DateLens: A Scalable Fisheye Calendar Interface”

76. January, 2003 **Sun Microsystems**, Menlo Park, CA
”Zoomable User Interfaces for Searching and Browsing”

77. September, 2002 **Microsoft Research Limited**, Cambridge, England
”Information Visualization for Mobile Devices”

78. July, 2002 **Microsoft Research**, Redmond ,WA
Demo of DateLens with Bill Gates at Microsoft Faculty Summit

79. July, 2002 **Microsoft Research**, Redmond, WA
”Scalable Interfaces for Mobile Devices”

80. June, 2002, **WebShop**, Dept. of Sociology, UMD, College Park, MD
”Access and Usability: The Importance of Internet Applications”

81. January, 2002 **Workshop on Election Standards and Technology**, Washington, DC
”Visualization Techniques for Electronic Voting”

82. October, 2001 **Microsoft Research**, Redmond, WA
“Zoomable User Interfaces for Searching and Browsing: SearchKids & PhotoMesa”

83. October, 2001 **Xerox PARC**, Palo Alto, CA
“Zoomable User Interfaces for Searching and Browsing: SearchKids & PhotoMesa”

84. November, 2000 **Census Bureau, Dept. of Commerce**, Suitland, MD
”Zoomable User Interfaces”

85. May, 2000 **Bowie State University**, Bowie, MD
“Zoomable User Interfaces and Single Display Groupware”

86. April, 2000 **University of Delaware**, DE
“Zoomable User Interfaces and Single Display Groupware”

87. August, 1999 **Xerox PARC**, Palo Alto, CA
“Zoomable User Interfaces and Single Display Groupware”

88. August, 1999 **University of California, Berkeley**, Berkeley, CA
“Zoomable User Interfaces and Single Display Groupware”

89. August, 1999 **Sun Microsystems, Inc. (Java Group)**, Palo Alto, CA
“Zoomable User Interfaces and Single Display Groupware”

90. July, 1999 **Nokia**, Linköping Sweden
"Zoomable Information Retrieval Systems and Single Display Groupware"

91. June, 1998 **IBM**, Yorktown, NY
"Zoomable User Interfaces"

92. May, 1998 **Washington DC Linux User's Group**, Alexandria, VA
"Zoomable User Interfaces"

93. April, 1998 **National Institute of Standards and Technology (NIST)**, Gaitherberg, MD
"Zoomable User Interfaces"

94. March, 1998 **Microsoft Research**, Redmond, WA
"Zoomable User Interfaces"

95. October, 1997 **Netherlands Design Institute**, Amsterdam, Holland
"Pad++: Zoomable User Interfaces"

96. October, 1997 **Philips Labs**, Eindhoven, Holland
"Pad++: Zoomable User Interfaces"

97. October, 1997 **CID, Royal Institute of Technology (KTY),** Stockholm, Sweden
"Pad++: Zoomable User Interfaces"

98. September, 1997 **Swedish Institute of Computer Science (SICS)**, Stockholm, Sweden
"Pad++: Zoomable User Interfaces"

99. October, 1996 **ART3000, A French society for the development of Art & Technology**, Paris, France
"Pad++: A Zoomable Graphical Interface"

100. October, 1996 **University of Michigan, Department of Information Sciences**, Ann Arbor, MI
"Pad++: A Zoomable Graphical Interface"

101. July, 1996 **AT&T Bell Labs**, NJ
"Pad++: A Zoomable Graphical Interface"

102. January, 1996 **Stanford University, Cognitive Psychology Group**, CA
"Pad++: A Zoomable Graphical Interface"

103. October, 1995 **Cornell University, Computer Science Department**, Ithaca, NY
"Pad++: A Zoomable Graphical Interface"

104. June, 1995 **Sandia National Labs**, Los Alamos, NM
"Pad++: A Zoomable Graphical Interface"

105. April, 1995 **Los Alamos National Labs**, Los Alamos, NM
"Pad++: A Zoomable Graphical Interface"

106. November, 1993 **Digital Equipment Corporation, Stanford Research Center**, CA
"Pad++: A Multiscale Hierarchical Sketchpad"

107. October, 1993 **Brown University, Computer Science Department**, Providence, RI
"Pad++: A Multiscale Hierarchical Sketchpad"

108. April, 1993 **University of Chicago, Computer Science Department**, |
"PA3D: A Multiscale Hierarchical Sketchpad"

109. October, 1992 **Rensselaer Polytechnic Institute, Computer Science Department**, Troy, NY
"Cortex-I: A Miniature Active Vision System"

H. ORIGINAL DESIGNS, PLANS, INVENTIONS, AND PATENTS

i. Patents

1. SanGiovanni, J., & **Bederson, B. B.** (Inventors). (2022) *Systems, methods, and computer program products displaying interactive elements on a canvas.* US Patent #11,243,673
2. **Bederson, B. B.,** & SanGiovanni, J. (Inventors). (2021) *Techniques to modify content and view content on a mobile device*. US Patent #11,061,524.
3. SanGiovanni, J., & **Bederson, B. B.**, and Painter, B. (Inventors). (2018) *Systems and methods for adaptive third party content*. US Patent #10,019,963.
4. SanGiovanni, J., & **Bederson, B. B.** (Inventors). (2018) *Systems, methods, and computer program products displaying interactive elements on a canvas*. US Patent #9,959,020.
5. **Bederson, B. B.,** & SanGiovanni, J. (Inventors). (2017) *Techniques to modify content and view content on mobile devices*. US Patent #9,778,810.
6. SanGiovanni, J., & **Bederson, B. B.** (Inventors). (2016) *Systems, Methods, and Computer Program Products Providing an Integrated User Interface for Reading Content*. US Patent #9,361,130.
7. SanGiovanni, J., & **Bederson, B. B.** (Inventors). (2014) *Systems, Methods, and Computer Program Products Displaying Interactive Elements on a Canvas.* US Patent #8,819,570.
8. Pahud, M., Murillo, O. E., Karlson, A. K., & **Bederson, B. B.** (Inventors). (2012). *Monitoring Pointer Trajectory and Modifying Display Interface*. US Patent #8,261,211.

9. Good, L.E., **Bederson, B. B.**, & Stefik, M.J. (Inventors). (2010). *Methods and Systems for Supporting Presentation Tools Using Zoomable User Interfaces*. US Patent #7,707,503.
10. **Bederson, B. B.**, Good, L. E., & Stefik, M.J. (Inventors). (2009). *Methods and Systems for Incrementally Changing Text Representation*. US Patent #7,650,562 B2.
11. **Bederson, B. B.**, Good, L. E., & Stefik, M. J. (Inventors). (2009). *Methods and Systems for Incrementally Changing Text Representation*. US Patent #7,549,114 B2.
12. Wallace, R. S., **Bederson, B. B.**, & Schwartz, E. L. (Inventors). (1997). *TV Picture Compression and Expansion*. US Patent #5,642,167.
13. **Bederson, B. B.**, Wallace, R. S., & Schwartz, E. L. (Inventors). (1993). *Two-Dimensional Pointing Motor*. US Patent #5,204,573.
14. Wallace, R. S., **Bederson, B. B.**, & Schwartz, E. L. (Inventors). (1992). *Telephone Line Picture Transmission*. US Patent #5,175,617.

ii. University Disclosures

1. **Bederson, B. B.** & Lin, J. (Inventors) (2009), CrowdFlow: A Computer-Human Hybrid Cloud Computing Model.
2. **Bederson, B. B.** (Inventor) (2002), Fisheye Calendar: A Calendar interface for small to large devices, IS-2002-015.
3. **Bederson, B. B.** (Inventor) (2001), PhotoMesa: A Zoomable Image Browser, IS-2001-053
4. **Bederson, B. B.**, & Chipman, L. G. (Inventors) (2000), *Physical Linear Slider Device to Control Computer Interface*, IS-2000-018.
5. **Bederson, B. B.** (Inventor) *Fisheye Menus For Selecting an Item From a Long List*, IS-2000-025.
6. **Bederson, B. B.**, Druin, A., & Pablo, J. P. (Inventors) (2000), *KidPad: A Collaborative Storytelling Environment for Children*, IS-2000-019.

I. CONTRACTS AND GRANTS

Total Funding: $18,036,144
UMD Portion: $10,329,299

1. **Ithaka SR, July 2016, co-PI**
   Elementary Statistics with an adaptive learning system
   $113,500
2. **Maryland Innovation Initiative, March 2014, PI**
   A Nationwide Database of Food Safety Inspections for Retail Establishments
   $100,000
3. **Huawei, July 2013, PI**
   XParty: Synchronous Online Language Learning
   $54,000
4. **Google, March 2013, PI**
   XParty: Synchronous Peer Learning in MOOCs (extension)
   $48,872
5. **Google, December 2011, PI**
   Search Party: Learning to Search in a Web-Based Classroom
   $60,000
6. **Alfred P. Sloan Foundation, November 2011, co-PI**
   Digital Disclosure of a Nationally Standardized Database of Restaurant Food Safety Inspections
   $465,272

7. **Google, June 2011, PI**
   Search Party: Web-Based Classroom Learning to Search
   $15,000

8. **Google, June 2011, co-PI**
   Translate the World: A Unified Framework for Crowdsourcing Translation
   $150,000

9. **Nokia Research, July 2010, PI**
   Mobile Learning
   $36,000

10. **NSF, CDI Type I: Translation as a Collaborative Process, Sep 2009, PI**
    $630,000

11. **Google, July 2009, PI**
    Translation as a Collaborative Process
    $70,000

12. **Sesame Workshop, January 2009, co-PI**
    Literacy 360 Alliance
    $22,500

13. **Eliassen Foundation, Nov 2008, co-PI**
    ICDL Elias Project
    $50,000

14. **Intel, Nov 2008, co-PI**
    ICDL ClassmatePC Project
    $50,000

15. **NSF, Designing and Understanding Intergenerational Mobile Learning Communities, Sep 2008, co-PI**
    $100,000

16. **Government of Mongolia Ministry of Education, Culture and Science – Nov2008, PI**
    International Children's Digital Library Phase 2
    $230,000
    $190,000 (for UMD)

17. **NSF, Usability Study of Independent Voter Verification Systems – July 2006, co-PI**
    PI – Paul Herrnson (Gov't & Politics)
    $68,000

18. **Government of Mongolia Ministry of Education, Culture and Science – May 2006, PI**
    Creating Digital Libraries in Mongolia
    $75,000

19. **IBM Faculty Award – December 2005, PI**
    Award to support my research on the open source Piccolo graphics toolkit.
    $30,000

20. **Maryland State Board of Elections, September 2005 – January 2006, co-PI**
    PI – Paul Herrnson (Gov't & Politics)
    $70,000

21. **(Agency not disclosed), April 2005 – March 2006, co-PI**
    Joint Institute for Knowledge Discovery
    $224,000 (my part of larger $2,000,000 effort led by VS Subrahmanian)

22. **Booz Allen (subcontract from ARDA), March 2005 – April 2006**
    Human-Information Interaction Research
    $325,000

23. **Toshiba, July 2004 – December 2006, PI**
Automatic Thumbnail Cropping
$20,000

24. **Microsoft, January 2004 – December 2006, PI**
Interaction Design and Visualization
$1,000,000

25. **DARPA, February, 2003 – January 2006, PI**
Zoomable User Interfaces for the Semantic Web
$230,000

26. **NSF, September, 2003 – August 2006, co-PI**
PI – Paul Herrnson (Gov't & Politics), co-PI, Richard Niemi (Univ. of Rochester), Michael Traugott (Univ. of Michigan)
An Assessment of Voting Technology and Ballot Design
$900,000 – approx $540K for UMD research

27. **Chevron, Oct 2002 – Oct 2003, co-PI**
PI – Catherine Plaisant (UMIACS)
Information Visualization for the Oilfield of the Future
$75,000

28. **IBM, September, 2002, PI**
T221 high-resolution display
$9,000 in kind

29. **IMLS, September, 2002 – August, 2005, co-PI**
PI – Allison Druin (CLIS)
The Children's International Digital Library
$397,162

30. **NSF, September, 2002 – August 2005, PI**
Search Interfaces for Biodiversity Informatics
$380,000

31. **NSF, September 2002 – August 2007, co-PI**
PI – Allison Druin (CLIS), co-PI, Anne Weeks
Developing a Children's International Digital Library
$3,000,000 ($2,125,000 to UMD)

32. **NSF, September 2002 – August 2005, co-PI**
co-PI – Allison Druin (CLIS), PI - Nancy Kaplan (Univ. of Baltimore), Stuart Malthrop (U. of Balt.)
An HCI Partnership Serving Under represented Groups
$420,000 ($133,000 to UMD)

33. **Microsoft Research, May 2002 – April 2001, PI**
Mobile Interfaces and .NET
$100,000

34. **Microsoft Research, September 2001 – August 2002, PI**
Mobile Interfaces
$50,000

35. **DARPA, May 2001 – August 2003, PI**
Zoomable User Interfaces for the Semantic Web
$320,000

36. **European Union – Esprit, The Disappearing Computer, Jan 2001 – December 2003, co-PI**
co-PI – Allison Druin (CLIS), Several PIs in Europe
With Royal Institute of Technology (KTH – Sweden), Univ. of Paris Sud, France.
InterLiving: Designing Interactive, Intergenerational Interfaces for Living Together
~$1,500,000 - approx $400K for UMD research

37. **Chevron, Nov 2000 – May, 2002, PI**
co-PI – Catherine Plaisant (UMIACS)
Information Visualization
$141,000

38. **DARPA, May 1998 – June 2002, PI**
Zoomable User Interfaces for InImEx and Command Post of the Future (CPOF)
$1,000,000

39. **Lockheed Martin Corp. sub-contract from DARPA, June 1999 - June 2000, PI**
Unified Zoomable Environment (UZE) for Command Post of the Future
$40,000

40. **European Union – Esprit, Intelligent Information Interfaces, Sept. 1998 – August 2001, co-PI**
co-PI – Allison Druin (CLIS), Several PIs in Europe
With Swedish Institute of Computer Science, Royal Institute of Technology (KTH – Sweden)
University of Nottingham, England.
KidStory
~$1,500,000 - approx $300K for UMD research

41. **Sun Microsystems, May 1999, PI**
Zoomable User Interfaces
$30,000 in equipment

42. **UNM sub-contract from DARPA, February 1998 – March 1999, PI**
Pad++: Zoomable User Interfaces
$200,000

43. **Microsoft, April, 1998, PI**
Productivity and development software
$5,000 in software and tech support

44. **Trivista, PI January 1998 - January 1999, PI**
Graphical User Interfaces based on Zooming
$50,000

UNIVERSITY OF NEW MEXICO

45. **Sony Research Corporation, PI**
co-PI – Jim Hollan (Univ. of New Mexico), co-PI – Ken Perlin (New York University)
Licensing of Pad++ software from UNM and NYU
$500,000 plus royalties

46. **Intel Donation, January, 1997, co-PI**
PI – Jim Hollan (Univ. of New Mexico)
200 MHz PC Computer
$4,000 in-kind

47. **DARPA, July'94 - June'97, Worked on grant with Jim Hollan**
Beyond Imitation: A Strategy For Building A New Generation of HCI Design Environments
$3,000,000 over 3 years with subcontracts to New York University and the Univ. of Michigan

48. **Sandia LDRD (Sandia internal research project) Oct'95 - Oct'96, PI**
Data Zooming - A New Physics for Information Navigation
$64,000

49. **Sandia SURP (Sandia University Research Program) Oct'95 - Oct'96, PI**
Pad++: A Zoomable Interface to the World-Wide Web
$40,000

50. **Sony Research Corporation, Jan'96, PI**
co-PI – Allison Druin (University of New Mexico)
Help plan Sony's efforts to develop a Zooming User Interface system
$3,674

51. **Sandia LDRD (Sandia internal research project) Oct'94 - Oct'95, Worked on grant with Jim Hollan**
$40,000

52. **Bellcore Donation, July'93, PI**
SGI Indigo Workstation computer
$30,000 in-kind

J. FELLOWSHIPS, PRIZES, AWARDS

1. **2022 – IEEE VIS Test of Time Award.** Joint with Catherine Plaisant and Jesse Grosjean – for my 2002 paper: SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation. *IEEE Symposium on Information Visualization, 2002. INFOVIS 2002.*, 2002, pp. 57-64, doi: 10.1109/INFVIS.2002.1173148. https://ieeevis.org/year/2022/info/awards/test-of-time-awards

2. **2021 – IEEE VIS Test of Time Award.** Joint with Ben Shneiderman and Martin Wattenberg – for my 2001 and 2002 papers: Ordered and Quantum Treemaps: Making effective use of 2D space to display hierarchies. Benjamin B. Bederson, Ben Shneiderman, Martin Wattenberg. ACM TOG 21(4):833-854 200 DOI: 10.1145/571647.571649. https://ieeevis.org/year/2021/info/awards/test-of-time-awards

3. **2016 – Winner of Best Historical Paper Award.** Joint with Pekka Parhi and Amy K. Karlson MobileHCI 2016 – 18th International Conference on Human-Computer Interaction With Mobile Devices and Services for "Target Size Study for One-Handed Thumb Use on Small Touchscreen Devices", MobileHCI 2006.

4. **2012 – Elected to the CHI Academy**
http://www.sigchi.org/about/awards/

   The CHI Academy is an honorary group of individuals who have made substantial contributions to the field of human-computer interaction. These are the principal leaders of the field, whose efforts have shaped the disciplines and/or industry, and led the research and/or innovation in human-computer interaction. The criteria for election to the CHI Academy are:
   - Cumulative contributions to the field.
   - Impact on the field through development of new research directions and/or innovations.
   - Influence on the work of others.

5. **2011 – Recognized as an ACM Distinguished Scientist**
http://awards.acm.org/distinguished_member/year.cfm

   The Distinguished Member Grade recognizes those ACM members with at least 15 years of professional experience and 5 years of continuous Professional Membership who have achieved significant accomplishments or have made a significant impact on the computing field.

6. **2010 – ICDL received the American Library Association President's Award for International Library Innovation**. Joint with Allison Druin and Ann Weeks.

7. **2010 – Winner of SIGCHI Social Impact Award**
http://www.sigchi.org/about/awards/2010-sigchi-awards

8. **2009 – Winner of Digital Education Achievement Award from the Center for Digital Education and Converge magazine**
For joint work on the International Children's Digital Library with Allison Druin and Ann Weeks.

9. **2007 – Winner of Brian Shackel Award for "outstanding contribution with international impact in the field of HCI"**
Karlson, A., & Bederson, B. B. (2007) ThumbSpace: Generalized One-Handed Input for Touchscreen-Based Mobile Devices, *Proceedings of INTERACT 2007*, 324-338.

10. **2005 – IBM Faculty Award**
$30,000 gift to support my work on open source Piccolo graphics toolkit

11. **2005 – The International Children's Digital Library (www.icdlbooks.org)** website was selected for inclusion by the National Endowment for the Humanities on their EDSITEment website (http://edsitement.neh.gov) as one of the best online resources for education in the humanities.

12. **2004 – Winner of InfoVis Contest**
Lee, B., Czerwinski, M., Robertson, G. G. &, Bederson, B. B. (2004). "Understanding Eight Years of InfoVis Conferences using PaperLens", InfoVis 2004, IEEE, 216-217.

13. **2003 – Winner of Best Student Paper Award**
Suh, B., Ling, H., Bederson, B. B., & Jacobs, J. W. (2003). "Automatic Thumbnail Cropping and Its Effectiveness". UIST 2003, ACM Symposium on User Interface Software and Technology, CHI Letters, 5(2), 95-104.

14. **1992 – Janet Fabri Memorial Award for Outstanding Doctoral Dissertation**,
Department of Computer Science, Courant Institute, New York University

K. REVIEWING ACTIVITIES

ACM Conference on Graphics (SIGGRAPH)
ACM Conference on Human Factors in Computing Systems (CHI)
ACM Conference on Information Retrieval (IR)
ACM Conference on User Interfaces and Software Technology (UIST)
ACM Transactions on Computer-Human Interaction (TOCHI)
Communications of the ACM (CACM)
Computer Graphics and Applications
Graphics Interface Conference, Canada (GI)
International Conference on Information Visualization
International Journal of Human-Computer Interaction
IEEE Symposium on Information Visualization (InfoVis)
IEEE Symposium on Visual Analytics Science and Technology (VAST)
IEEE Transactions on Software Engineering (TSE)
IEEE Transactions on Visualization and Computer Graphics (TVCG)
Journal of Experimental Algorithmics
Journal of Information Visualization
Journal of Software Practice and Engineering (SPE)
NSERC (Canadian scientific funding agency)
National Science Foundation

L. OTHER
i. Software

StoryKit	iPhone app for children and their elders to create new books. Put in iPhone App Store August, 2009. Typical usage of 100,000 hours of story writing per month.
ICDL for iPhone	iPhone app for reading books from the International Children's Digital Library. Put in iPhone App Store November, 2008.
International Children's Digital Library	A library of children's books. Put on the Web Nov, 2002. http://www.childrensbooks.org • Unique accessors total: > 7,000,000 • Unique accessors monthly: ~130,000
DateLens	A calendar program for PDAs. Put on the Web July, 2002
SpaceTree	A general purpose tree browser. Put on the Web Dec, 2002. http://www.cs.umd.edu/hcil/spacetree
PhotoMesa	An end-user zoomable photo browser. Put on the Web May, 2001. http://www.cs.umd.edu/hcil/photomesa
CounterPoint	A zoomable presentation tool that works as a plug-in for Microsoft PowerPoint. Put on the Web in late 2001. http://www.cs.umd.edu/hcil/counterpoint
Piccolo	A library to support structured 2D graphics, the successor to jazz. Put on the Web in July 2002. http://www.cs.umd.edu/hcil/piccolo
Jazz	A general-purpose Java toolkit for building Zoomable User Interfaces. Put on the Web as Open Source software July 1999. http://www.cs.umd.edu/hcil/jazz
KidPad	An application that teaches young children communication skills through collaborative storytelling. Built using MID and KidPad. Put on the Web for non-commercial use March 2000. Access through March 2001 follow. http://www.cs.umd.edu/hcil/kidpad
Fisheye Menus	A new user interface widget for selecting one item for a long list using graphical distortion. Put on the Web for non-commercial use June 2000. Access through March 2001 follow. http://www.cs.umd.edu/hcil/fisheyemenu
MID	A general-purpose Java toolkit for supporting multiple input devices. It currently supports multiple USB mice on Windows 98. Put on the Web as Open Source software July 1999. It is used by the small but growing community of researchers investigating Single Display Groupware http://www.cs.umd.edu/hcil/mid
Pad++	Pad++ is described in detail in the papers referenced above. http://www.cs.umd.edu/hcil/pad++
Togl	An extension to Tcl/Tk that allows the creation of OpenGL graphics written in C to appear in a window managed by Tk. In addition, Tcl event bindings can be attached to the window which can then communicate with the C code that did the OpenGL rendering. Put on the net for public access. http://togl.sourceforge.net/

ii. Media

1. February 2, 2017 **The Diamondback** by Carly Taylor
"McKeldin Mall's Newest Academic Building Will Be Completed in March After Nearly 3 Years"
http://www.dbknews.com/2017/02/02/edward-st-john-construction-umd/

2. August 29, 2016 **The Diamondback** by Andrew Dunn
"University System of Maryland to offer an online course for free"
http://www.dbknews.com/2016/08/30/mooc-umb-umuc-online-usm/

3. February 15, 2016 **The Diamondback** by Samantha Reilly
"SGA passes resolution to revive 2012 syllabus bill"
http://www.dbknews.com/2016/02/16/umd-sga-passes-syllabus-resolution-to-revive-university-senate-bill/

4. September 24, 2015 **The Diamondback** by Taylor Swaak
"Active-Learning Courses Gain Traction at the University of Maryland"
http://www.diamondbackonline.com/news/active-learning-courses-gain-traction-at-the-university-of-maryland/article_435098ca-6247-11e5-a8e2-df59d97181a5.html

5. September 14, 2015 **Washington Post Express** by Beth Luberecki
"Massive open online courses (MOOCs) can help you achieve the next step in your career"
https://www.washingtonpost.com/express/wp/2015/09/14/massive-open-online-courses-moocs-can-help-you-achieve-the-next-step-in-your-career/

6. April 30, 2015 **The Diamondback** by Talia Richman
"USM Center for Academic Innovation to be renamed to honor Brit Kirwan"
http://www.diamondbackonline.com/news/article_51cbc02c-eeb7-11e4-a838-6b9857ba8e37.html

7. April 13, 2015 **The Diamondback** by Rokia Hassanein
"UMD Team Creates Nation's Largest Food Safety Inspection Database"
http://www.diamondbackonline.com/news/article_553da506-e181-11e4-b6c9-0f23d720b7cc.html#.VS1VV_HbNqc.twitter

8. April 6, 2015 **Quality Assurance & Food Safety Magazine**
"Database of Food Safety Inspection Information Created"
http://www.qualityassurancemag.com/food-safety-inspection-information.aspx

9. February 23, 2015 **Diamondback, UMD Student Newspaper** by Taylor Swaak
"New UMD website offers alternative ways to save money on textbooks"
http://www.diamondbackonline.com/news/article_0d910a34-baf5-11e4-826a-dfbcb9e8b5f8.html

10. January 13, 2015 **WAMU Kojo Nnamdi Show**
"The Rise of Mobile Apps"
http://thekojonnamdishow.org/shows/2015-01-13/tt_the_rise_of_mobile_apps

11. October 1, 2014 **The Chronicle of Higher Education**
"Optimism About MOOCs Fades in Campus IT Offices"
http://chronicle.com/blogs/wiredcampus/optimism-about-moocs-fades-in-campus-it-offices-survey-finds/54705

12. September 8, 2014 **WAMU Kojo Nnamdi Show**
"Beefing Up Photo, Cloud and Online Security"
http://thekojonnamdishow.org/shows/2014-09-09/beefing-photo-cloud-and-online-security

13. April 29, 2014 **Diamondback, UMD Student Newspaper** by James Levin
"Learning to ask for help"
http://www.diamondbackonline.com/news/article_632cbbb8-cf5b-11e3-b8b4-0017a43b2370.html

14. April 18, 2014 **CNN.com** by Emanuella Grinberg
"Removing 'barriers' to education through free college textbooks"
http://www.cnn.com/2014/04/18/living/open-textbooks-online-education-resources/

15. January 27, 2014 **DiamondBack, UMD Student Newspaper** by Ellie Silverman
"University expanding online class sequences through Vanderbilt partnership"
http://www.diamondbackonline.com/news/campus/article_dff739f4-86ed-11e3-9a18-001a4bcf6878.html

16. September 27, 2013 **Baltimore Business Journal** by Sarah Gantz
"Maryland Schools use Online Model to Tout Brand, Attract Students"
http://www.bizjournals.com/baltimore/print-edition/2013/09/27/maryland-schools-use-online-model-to.html?page=all

17. July 16, 2013 **HuffingtonPost.com**
"Blended Learning: College Classrooms of the Future"
http://www.huffingtonpost.com/uloop/blended-learning-college-_b_3598718.html

18. December 5, 2012 **Diamondback, UMD Student Newspaper** by Allison Gray
"University members hoping to see 'massive open online courses' integrated"
http://www.diamondbackonline.com/news/article_4873330c-3ef1-11e2-9a16-0019bb30f31a.html

19. September 21, 2012 **SmartMoney.com** by Quentin Fottrell
In Apple's Maps War vs. Google, Consumers Lose
http://blogs.smartmoney.com/advice/2012/09/21/in-apples-maps-war-vs-google-consumers-lose/?link=SM_hp_ls4e

20. September 18, 2012 **WAMU Kojo Nnamdi Show**
"Creativity and the Patent Wars" (guest on one-hour show)
http://thekojonnamdishow.org/shows/2012-09-18/creativity-and-patent-wars

21. September 7, 2012 **New York Magazine** by Matthew Shaer
"The Digital Elite: Smartphones are getting huge. Can the average-size thumb keep up?" (discusses my study on thumb size and mobile touch screens.

22. Aug 13, 2012 **Fact Witness in Apple v. Samsung trial covered broadly**
http://blogs.wsj.com/digits/2012/08/13/samsungs-first-witnesses-push-prior-art-after-minor-victory/

http://news.cnet.com/8301-13579_3-57492486-37/samsung-goes-on-offense-aims-to-bust-apple-patents/

http://arstechnica.com/tech-policy/2012/08/apple-rests-patent-case-as-judge-tosses-three-samsung-phones-from-trial/

http://www.forbes.com/sites/connieguglielmo/2012/08/13/apple-says-it-complained-about-samsung-copying-in-2010-live-blog/

http://allthingsd.com/20120813/judge-refuses-to-toss-most-of-apples-suit-against-samsung/

http://www.theverge.com/2012/8/13/3240686/samsung-apple-patents-launchtile-diamondtouch-table

http://www.eweek.com/c/a/Mobile-and-Wireless/Samsung-Begins-Presenting-Case-in-Apple-Patent-Infringement-Trial-162894/

23. May 7, 2012 **WAMU Kojo Nnamdi Show**
"Free Online Courses - Higher Ed of the Future?" (guest on hour show)
http://thekojonnamdishow.org/shows/2012-05-07/free-online-courses-higher-ed-future

24. January 24, 2012 **Washington Post** by Bonnie Berkowitz and Alberto Cuadra
"Touchscreens: How they work", I am the primary source
http://www.washingtonpost.com/national/health-science/touchscreens-how-they-work/2012/01/23/gIQAZHlAMQ_graphic.html

25. June 28, 2011 **New Scientist** by Jim Giles
"The man-machine: Harnessing humans in a hive mind", discussed MonoTrans.
http://www.newscientist.com/article/mg21028181.900-the-manmachine-harnessing-humans-in-a-hive-mind.html

26. June 14, 2011 **WAMU Kojo Nnamdi Show**
"A Shift in Cloud Computing" (guest on hour show)
http://thekojonnamdishow.org/shows/2011-06-14/shift-cloud-computing

27. May 13, 2011 **Discovery News** by Alyssa Danigelis
"Tech Turns Air into a Multi-touch screen", quoted.
http://news.discovery.com/tech/touch-screen-technology-zerotouch-110513.html

28. April 28, 2011 **Converge Magazine** by Tanya Roscorla
"Music Apps Take Top Prizes in U of Maryland Contest", discusses mobile app from the University of Maryland mobile app contest that I ran.

29. April 26, 2011 **Voice of America** by Do Noghte Sefr (in Persian)
"Mobility Initiative ابتکار تحرک"
http://www.youtube.com/donoghtesefr

30. April 24, 2011 **Washington Post**
"Business Rx: A jukebox democracy in search of voters", discusses mobile app from the University of Maryland mobile app contest that I ran.

31. February 25, 2011 **New Scientist** by Jim Giles and Jacob Aron
"Crowdsourced translations get the word out from Libya", discusses my MonoTrans project
http://www.newscientist.com/article/dn20174-crowdsourced-translations-get-the-word-out-from-libya.html

32. February 9, 2011 **DiamondBack, UMD Student Newspaper**
"Creativity at her fingertips" by Erin Egan
http://www.diamondbackonline.com/news/article_f7143841-131c-5695-a310-42596336345d.html

33. February 8, 2011 **WAMU Kojo Nnamdi Show**
"A Revolution in Tech Jobs? The Murky World of Online Labor" (hour show with me as only guest)
http://thekojonnamdishow.org/shows/2011-02-08/revolution-tech-jobs-murky-world-online-labor

34. November 23, 2010 **WAMU Kojo Nnamdi Show**
"The End of Email and other Tech Prognostications"
(hour show with me and one other guest)
http://thekojonnamdishow.org/shows/2010-11-23/end-email-and-other-tech-prognostications

35. November 9, 2010 **MIT Technology Review** by Erica Naone
"Gesturing at Your TV Isn't Ready for Prime Time" quotes me discussing Microsoft Kinect
http://www.technologyreview.com/computing/26691/

36. October 27, 2010 **MIT News** by Larry Hardesty
"Programming crowds" quotes me in analyzing Rob Miller's work
http://web.mit.edu/newsoffice/2010/programming-crowds-1027.html

37. October 2, 2010 **News 8 TV Austin**
"App Wrap: eReading for Kids" discussing StoryKit app for iPhone
http://www.news8austin.com/content/headlines/274426/app-wrap--ereading-for-kids

38. August 24, 2010 **WAMU Kojo Nnamdi Show**
"Automating Language Translation: The Future of a Unified Internet?" discussing my research and the general topic of crowdsourcing and translation.
http://thekojonnamdishow.org/shows/2010-08-24/automating-language-translation-future-unified-internet

39. May 4, 2010 **Technology Review**
"Redesigning the Web for Touch Screens"
http://www.technologyreview.com/printer_friendly_article.aspx?id=25236&channel=computing&section=

40. April 2010 **FutureGov Magazine** by Kelly Ng, Singapore
Description of ICDL for iPad application

41. April 17, 2010 **ABC 7 News, WLS-TV Chicago**
"Chicago Students Face Off in Battle of Books"
http://abclocal.go.com/wls/story?section=news/local&id=7392055

42. April 8, 2010 **Publisher's Weekly**
"The iPad Meets the Children's Book"
http://www.publishersweekly.com/article/455914-The_iPad_Meets_the_Children_s_Book.php?nid=2788&source=link&rid=16811925

43. April 3, 2010 **The Independent**, London
"Chlidren's book iPad apps offer multilingual tales, long-distance bedtime stories"
http://www.independent.co.uk/arts-entertainment/books/childrens-book-ipad-apps-offer-multilingual-tales-longdistance-bedtime-stories-1934847.html

44. January 28, 2010 **Baltimore Sun**, Baltimore, MD
"Apple unveils tablet computer" by Gus G. Sentementes
http://www.baltimoresun.com/business/technology/bal-bz.ipad28jan28,0,5120135.story

45. December 2009 **FutureGov Magazine** by Kelly Ng, Singapore
"Inside the Teacher's Lounge" covered Ben's keynote UNESCO talk in Hangzhou, China

46. November 20, 2009 **World Bank Blog**
http://blogs.worldbank.org/edutech/icdl-1

47. November 2, 2009 **Technology Review.com**
"First Test for Election Cryptography"
http://www.technologyreview.com/web/23836/

48. December 23, 2008 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy"

49. September 18, 2008 **America.gov**
"Kids Help Design International Children's Digital Library" by Jeffrey Thomas
http://www.america.gov/st/educ-english/2008/September/200809181459141CJsamohT0.2946283.html
Also published in **gulf-times.com** in Qatar
http://www.gulf-times.com/site/topics/article.asp?cu_no=2&item_no=245520&version=1&template_id=46&parent_id=26

50. April 25, 2008 **C|Net News.com**
"The Six Secrets of Mobile Computing Success" by Tom Krazit

51. February 8, 2008 **WYPR Maryland Morning**, Baltimore, MD
10 minute radio interview about usability of voting systems

52. January 30, 2008 **KCSN News** by Jessica Caldera
Short radio interview about usability of voting systems

53. January 29, 2008 **Technology Review.com** by Erica Naone
"Voting with (Little) Confidence"
http://www.technologyreview.com/Infotech/20122/

54. January 28, 2008 **ScienceDaily.com**
"Touch Screen Voting A Hit; Critics Miss Mark on Security, Study Says"
http://www.sciencedaily.com/releases/2008/01/080123170954.htm

55. January 26, 2008 **Newsweek** by Barrett Sheridan
"Like a Super Hero: Humans weren't made for scrolling and searching. We were made for zooming."
http://www.newsweek.com/id/105532/output/print

56. January 25, 2008 **Government Executive.com** by Gautham Nagesh
"Voters confused by e-voting machines, study finds"
http://www.govexec.com/dailyfed/0108/012508n1.htm

57. January 22, 2008 **WAMU Kojo Nnamdi Show**, Washington, DC
Thirty minute segment on "Technology User Frustrations – Spotlight on Cellphones"
http://wamu.org/programs/kn/08/01/22.php#19083

58. January 16, 2008 **KUOW, The Conversation**, Seattle, WA
The guest on an hour-long call-in talk show on the future of cellphones.
http://www.kuow.org/defaultProgram.asp?ID=14159

59. October 30, 2007 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy", talking about software reliability

60. August 7, 2007 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy", current tech events, iPhone, Tivo, and listeners email and calls
http://wamu.org/programs/kn/07/08/07.php

61. June 13, 2007 **New York Times** by John Markoff
"That iPhone has a keyboard, but it's not mechanical"
http://www.nytimes.com/2007/06/13/technology/13phone.ready.html

62. June 5, 2007 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy", Microsoft Surface, cell phone problems, and listeners email and calls
http://wamu.org/programs/kn/computerguys/07/cg070605.php

63. April 3, 2007 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy", Physical and virtual convergence, and listeners email and calls
http://wamu.org/programs/kn/computerguys/07/cg070403.php

64. March 17, 2007 **Science News** weekly magazine, by Ivars Peterson
"Games Theory", several quotes by me on article about von Ahn's games.
http://www.sciencenews.org/articles/20070317/bob9.asp

65. January 18, 2007 **Wall Street Journal**, by Jeremy Wagstaff
"The March of Time", covering DateLens

66. December 31, 2006 **Associated Press**, by Brian Bergstein
"Low-Cost Laptop Could Transform Learning"
http://www.washingtonpost.com/wp-dyn/content/article/2006/12/31/AR2006123100380.html
AP story picked up in 175 locations, including:

    - Washington Post
    - BusinessWeek
    - Chicago Tribune
    - Boston Globe
    - ABC News
    - CNN
    - FOX News
    - Eyewitness News
    - Forbes
    - BBC News, UK
    - Sydney Morning Herald, Australia
    - The Age, Australia
    - Economic Times, India

67. December 5, 2006 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy", Vista, holiday tech gifts, and listeners email and calls
http://www.wamu.org/programs/kn/06/12/05.php#12452

68. September 22, 2006 **Salon.com** by Katharine Mieszkowski
"Written out of the story", discussing write-in votes using the Hart eSlate system
http://www.salon.com/news/feature/2006/09/22/delay_write_in/index_np.html

69. May 2, 2006 **WAMU Kojo Nnamdi Show**, Washington, DC
"Computer Guy – life in the fast lane", discussing broadband at home
http://www.wamu.org/programs/kn/06/05/02.php#10686

70. April 23, 2006 **Pittsburgh Post-Gazette** by Mark Roth
"Experts see computers getting bigger and smaller at the same time"
http://www.post-gazette.com/pg/06113/684425-96.stm

71. March 9, 2006 **Baltimore Sun** by Mike Himowitz
"PhotoMesa a nifty way to organize photographs"
http://www.baltimoresun.com/technology/bal-bz.himowitz09mar09,0,3518441.column

72. February 21, 2006 **WAMU Kojo Nnamdi Show**, Washington, DC
"Wiki Sites"
http://www.wamu.org/programs/kn/06/02/21.php#10383

73. February 3, 2006 **Baltimore Sun** by Frank D. Roylance
"Spreading the e-word" (quoted about Sony's new ebook reader e-paper)
http://www.baltimoresun.com/news/health/bal-hs.eink03feb03,1,3010066.story

74. January 13, 2006 **Washington Business Journal** by Jennifer Nycz-Conner
"What was I doing, again?"
http://www.bizjournals.com/washington/stories/2006/01/16/focus1.html

75. November 18, 2005 **c|net News.com** by Stefanie Olsen
"The 'millenials' usher in a new era" (about ICDL)
http://news.com.com/The+millennials+usher+in+a+new+era/2009-1025_3-5944666.html?tag=nefd.lede

76. September, 2005 **Chicago Parent** by Jane Huth
"Screen time=reading time"
http://www.chicagoparent.com/main.asp?SectionID=10&SubSectionID=32&ArticleID=529&TM=67415.63

77. September 22, 2005 **Delphos Herald**
"Site Seeing"
http://www.delphosherald.com/page2.php?story=8655&archive=

78. April, 2005 **Chicago Parent** by Judy Belanger
"Explore the world by turning pages"
http://www.chicagoparent.com/main.asp?SectionID=10&SubSectionID=33&ArticleID=306&TM=67012.6

79. April 5, 2005 **EE Times** by Nicolas Mokhoff
" Microsoft touts 'thumb-as-stylus' interface progress"
http://www.eetimes.com/showArticle.jhtml;jsessionid=NHVZOY3L1AQWUQSNDBGCKH0CJUMEKJVN?articleID=160500234
Also picked up by **Information Week**

80. March 10, 2005 **folha equilibrio (Brazil)** by Sérgio Rizzo
"Cibertentações" (article about computer-based distraction, describing some of my work.)

81. March, 2005 **Radio City (Ecuador) / BBC Affiliate**
5 minute radio interview (performed in English, translated into Spanish)

82. March 1, 2005 **The Statesman (India)** by Stanley Theodore
"Webcrawler: All About E-Attention Deficit Disorder"
http://www.thestatesman.net/page.news.php?clid=24&theme=&usrsess=1&id=70119

83. February 28, 2005 **Washington Times** by Ann Geracimos
"New Chapter in Online Books"
http://washingtontimes.com/metro/20050227-101610-1015r.htm

84. February 18, 2005 **North Carolina State Technician** by Danny Frye
"Research targets computer distraction such as AIM"
http://technicianonline.com/story.php?id=011167

85. February 13, 2005 **Bloomberg Radio, "Simply Put"** by Michael Goldman & Tom Moroney
9 minute interview discussing attention and interruptions on the computer

86. February 10, 2005 **New York Times** by Katie Hafner
"You There, at the Computer: Pay Attention"
http://www.nytimes.com/2005/02/10/technology/circuits/10info.html
Also picked up by
    a. **International Herald Tribune (France)**
    b. **ABS CBN News (Philippines)**
    c. **CNET News.com**
    d. **Spartanburg Herald (SC)**
    e. **Wilmington Morning Star (NC)**
    f. **Minneapolis Star Tribune (MN)**

87. Nov 11, 2004 **Maryland Public Television** by Frank Batavick
"Message in a Bottle", Bob the vid-tech guy 30 minute special including 5 minute segment of Allison Druin and me explaining email and instant messaging to children.

88. May 7, 2004 **Baltimore Sun** by Elizabeth Schuman
"Research Lab Crosses Cultures"

89. October 20, 2003 **The Feature** by Jeff Goldman
"A View Into Your Phone"
http://www.thefeature.com/article?articleid=100146

90. October 10, 2003 **The Independent** by Charles Arthur
"Treemap Offers a New Way of Visualizing Complex Data. Nothing Beats it for Simplicity and the "wow!" effect when you first use it."
http://news.independent.co.uk/digital/features/story.jsp?story=451099

91. July, 2003 **Higher Learning – Technology Serving Education**
"Web Sites: The International Children's Digital Library"

92. July 7, 2003 **Pittsburgh Post-Gazette** by Karen MacPherson
"Web Site Invites Children to Read Online: International Children's Digital Library Caters to Young Around the Globe"

93. June 15, 2003 **San Antonio News 9** by Michael Garfield
"Website a Fun Way to Encourage Kids to Read"

94. April 11, 2003 **San Jose Mercury News** by Dan Gillmor
"Designing New Handhelds to Improve Interactions Between Humans, Computers"
Also picked up by **New Jersey Star Ledger (NJ)**

95. February 12, 2003 **Tech TV Live** by Peter Barnes
Also on **abcnews.com**
"Easy Online Reader: An International Online Nook for Children's Books"

96. January 17, 2003 **Voice of America TV** by Larry Clamage
4.5 minute video of children's design team focusing on ICDL

97. December, 2002 **Sun's Java Website**
ICDL Linked to from http://java.sun.com/industry/

98. December 17, 2002 **Associated Press**
Picture of Ben Bederson w/ Bill Gates at Microsoft about DateLens project
    a. **Seattle Post Intelligencer (WA)**
    b. **Times Daily (AL)**
    c. **Sarasota Herald-Tribute (FL)**
    d. **Naples Daily (FL)**

99. December 16, 2002 **Baltimore Sun** by Alex MacGillis
"Two Study Intricacies of Voting Machines"
Also picked up by AP, excerpts in:
    a. **USA Today**
    b. **WMAR (MD)**
    c. **WBAL-TV (MD)**
    d. **News Channel 8.net**

100. December 12, 2002 **Philadelphia Inquirer** by Joyce Kasman Valenza
"tech.life @ school | New virtual library offers children much"

101. December 10, 2002 **Le Monde (France)** by Chantal Dussuel
"Livres en ligne pour internautes on herbe"

102. December 10, 2002 **Christian Science Monitor**
News in Brief – ICDL

103. December 5, 2002 **New York Times** by Lisa Guernsey
"Online Library Project Plans a Digital and Cultural Trove for Children"

104. December 1, 2002 **Die Burger (South Africa)**
"Paragrawe"

105. November 30, 2002 **The Vancouver Sun (Canada)**
"Book Endz: Free Kid's Books"

106. November 30, 2002 **La Vanguardia (Spain)**
"Nuevos Proyectos: TalentMatch.com, International Children's Digital Library SoapCity"

107. November 27, 2002 **USA Today** by Karen Thomas
"World Books, Children Click"

108. November 27, 2002 **The Ohama World-Herald**
"TechBytes: Digital Library Links Kids to Other Cultures"

109. November 27, 2002 **Education Week**
"Internet Library for Children Invites the World to Read"

110. November 26, 2002 **The Gold Coast Bulletin (Australia)**
"The Net: News Bytes"

111. November 25, 2002 **intern.de (Germany)**
"Kinderbibliothek"

112. November 25, 2002 **Seattle Post-Intelligencer**
"Kids Books Now Online"

113. November 21, 2002 **AP Wire** by Sam Hannel
"Web Site to Give Free Access to Children's Books"
    a. **ABCNews.com**
    b. **The Age (Australia)**
    c. **Ananova.com (UK)**
    d. **Asia Pacific Media Network**
    e. **The Baltimore Sun**
    f. **Globetechnology.com (Canada)**
    g. **KTVU 2 News (Bay Area)**
    h. **Indiana Gazette**
    i. **MSNBC.com**
    j. **Newsday.com**
    k. **Rapid City Journal**
    l. **San Jose Mercury News**
    m. **Sarasota Herald-Tribune (Florida)**
    n. **Santa Fe New Mexican**
    o. **Seattle Post-Intelligencer**
    p. **Sydney Morning Herald (Australia)**
    q. **Waterloo/Cedar Falls**
    r. **WFTV (Florida)**

114. November 21, 2002 **24ur.com (Slovenia)**
"Knjige brezplacno na internetu"

115. November 21, 2002 **Courier Mail (Australia)**

116. November 21, 2002 **United Press International (UPI)**
"New Online Library for Kids Launched"

117. November 21, 2002 **Washington Post (.COM Column)** by Leslie Walker
"A Library for Young Browsers"
    a. **International Herald Tribute**
    b. **SFGate.com (San Francisco)**

118. November 21, 2002 **Internet Magazine**
"Site Offers Free Access to Kids Books"

119. November 20, 2002 **Magasinet (Norway)**
"Lager verdensbarnebibliotek"

120. November 20, 2002 **Fox 5 TV News** by John Henrehan
Live 1.5 minutes on 5:00pm news

121. November 18, 2002 **All Things Considered on NPR** by David Kestenbaum
”Library for Kids Goes Online” (11 minutes)

122. October, 2002 **Digital Computer Magazine**
Review of PhotoMesa

123. September 23, 2002 **ComputerSweden** by Anders Lotsson
”Square Zoom in the Hand”

124. August 19, 2002 **Ohio Repository** by Joan Renner
”Ensuring validity is a big concern in electronic voting”

125. August 18, 2002 **Ohio Repository** by Joan Renner
”Voting test shows pros, cons”

126. August 12, 2002 **eWeek**, by Anne Chen
”DateLens Stays Organized in C#”

127. August 5, 2002 **Grid Today**
”Bill Gates Highlights Academic Collaboration Key to Future”

128. July 29, 2002 **eWeek**, by Anne Chen
”Gates: .NET Won’t Happen Overnight”

129. July 29, 2002 **InfoWorld**, by Matt Berger
”Gates, academics joins on security, shared source”

130. July 29, 2002 **NetworkWorldFusion**, by Matt Berger
”Gates, academics joins on security, shared source”

131. May 9, 2002 **Washington Post (.COM Column)**, by Leslie Walker
”A Visual Rather Than Verbal Future”

132. May 9, 2002 **Washington Post Website**, by Eleanor Hong
”Human-Computer Interaction Lab at the University of Maryland” – Interview with me, Allison Druin, and Ben Shneiderman.

133. August 1, 2001 **Sun Microsystems Java Website**, by Jon Byous
”View With a Zoom: Browse and Zoom Digital Images in One Application” describes PhotoMesa and my treemap algorithms.

134. July 2, 2001 **ComputerWorld** by Sami Lais
”Treemaps Bloom” describes my photo browser application PhotoMesa which uses Jazz

135. June 4, 2001 **ComputerWorld** by Sami Lais
”Software for the 4th Dimension” describes TimeSearcher which uses Jazz

136. August 12, 2000 **New Scientist Magazine**
”Maximizing MinimalisM”, an article Zoomable User Interfaces, KidPad, and Fisheye Menus

137. Fall, 2000 **College Park**, by Tom Ventsias
”Zooming Ahead”, an article about Zoomable User Interfaces

138. June 26, 2000 **ComputerWorld**, by Sami Lais
”Zoomin’ Ahead”, an article about Zoomable User Interfaces and Fisheye Menus

139. September, 1999 **Sun Microsystems Java Website**, by Jon Byous
An interview with me under their face-to-face column.

140. December 21, 1998 **Baltimore Sun**
Reprinted in New York Newsday, Dec. 30, 1998
“Children first: In designing toys, one lab turns to the experts in the field.”

141. April 4, 1997 **The Chronicle of Higher Education** by Jeffrey R. Young
"New Ways of Organizing Data Could Change Nature of Computers"

142. February, 1997 **Nov'Art**
a French Magazine sponsored by Art3000, a society devoted to integration of technology and art.

143. October 23, 1996 **The New York Times Online (CyberTimes)** by Ashley Dunn
"Seeing the Forest of Knowledge for the Trees of Data"

144. June, 1995 **The X Advisor**, by Gary Welz
"Peripheral Visions: Zooming Through Information Space on Pad++"

3. TEACHING AND ADVISING

A. COURSES TAUGHT

i. General

Fall 2015 — *Paths to CS* (CMSC198C/D/E) – 96 Students

Fall 2013 — *Paths to CS* (CMSC198C/D/E, 1-3 credits) – 36 Students

CMSC198C

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.6 (College comparison: 2.8)
- Effective teacher: 3.9 (College comparison: 2.9)

CMSC198D

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.8 (College comparison: 2.8)
- Effective teacher: 4.0 (College comparison: 2.9)

Fall 2012 — *Tech for CS Startups – Team taught* (CMSC 498E, 1 credit) – 19 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.0 (College comparison: 3.2)
- Effective teacher: 3.7 (College comparison: 2.9)

Spring 2012 — *Reading Seminar: Future of HCI – Team taught* (CMSC 838B, 1 credit) – 13 Students

Fall 2011 — *Social Computing Seminar* (CMSC 838B, 3 credits) – 20 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.7 (College comparison: 3.2)
- Effective teacher: 3.8 (College comparison: 3.2)

Fall 2011 — *Intro to Human-Computer Interaction* (CMSC 434) – 37 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.5 (College comparison: 3.2)
- Effective teacher: 3.5 (College comparison: 3.0)

Spring 2011 — *Intro to Human-Computer Interaction* (CMSC 434) – 42 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 2.9 (College comparison: 3.2)
- Effective teacher: 3.0 (College comparison: 3.0)

Fall 2010 — *Reading Seminar in Human Computation* (CMSC 838B, 1 credit) – 9 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.8 (College comparison: 3.2)
- Effective teacher: 3.9 (College comparison: 3.5)

Fall 2010 — *Digital Cultures and Creativity* (HDCC 105, co-taught) – 56 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 2.4 (College comparison: 2.5)
- Effective teacher: 3.2 (College comparison: 3.4)

Spring 2010 — *Object-Oriented Programming I* (CMSC 131H) – 10 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.8 (College comparison: 2.9)
- Effective teacher: 4.0 (College comparison: 3.0)

Fall 2009 — *Intro to Human-Computer Interaction* (CMSC 434) – 39 Students

Student Evaluations (Scale: 0 Poor – 4 Excellent)
- Students "learned a lot": 3.3 (College comparison: 3.2)
- Effective teacher: 3.5 (College comparison: 3.0)

Spring 2008 *Intro to Human-Computer Interaction* (CMSC 434) – 32 Students
Student Evaluations (Scale: 0 Poor – 4 Excellent)
Students "learned a lot": 3.1 (College comparison: 3.1)
Effective teacher: 3.2 (College comparison: 3.0)

Spring 2005 *Developing User Interfaces* (CMSC 498B) – 14 Students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.6
Instructor's teaching: 3.8

Spring 2004 *Object Oriented Programming I* (CMSC 131) – 75 Students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.0
Instructor's teaching: 2.9

Spring 2003 *Information Visualization* (CMSC 828B) – 17 Students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.1
Instructor's teaching: 3.4

Spring 2002 *Developing User Interfaces* (CMSC 498B) – 25 Students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.6
Instructor's teaching: 3.9

Fall 2001 *Human Computer Interaction* (CMSC 434/828S) – 50 Students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.5
Instructor's teaching: 3.6

Spring 2001 *Information Visualization*
Taught by Catherine Plaisant and Ben Shneiderman due to my illness

Fall 2000 *Human Computer Interaction* (CMSC 434/828S) – 50 Student*s*
No evaluation due to my illness

Spring 2000 *Computer Graphics* (CMSC 427) – 45 students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.4
Instructor's teaching: 3.3

Fall 1999 *Human Computer Interaction* (CMSC 434/828S) – 44 Students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.9
Instructor's teaching: 3.9

Spring 1999 *Zoomable User Interfaces* (CMSC 838B) – 15 Students

Fall 1998 *Software Engineering* (CMSC 435) – 45 students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.6
Instructor's teaching: 3.5

Spring 1998 *Computer Graphics* (CMSC 427) – 24 students
Student Evaluations (Scale: 0 Poor - 4 Excellent)
Course quality: 3.7
Instructor's teaching: 3.7

Spring 1997 *Software Engineering* (CS460) @ UNM
(Didn't receive evaluations)

Fall 1996 *Introduction to Data Structures* (CS251) - 100 Students @ UNM
(Didn't receive evaluations)

Spring 1996	*Human Computer Interaction* (CS462) @ UNM Student Evaluations (ICES scale: 1 poor - 6 excellent) Course content: 5.2 Instructor: 5.5 Course in general: 5.2
Spring 1996	*Computers & Society* (CS491/591) @ UNM Introduced this course for the first time in the CS dept. 1 credit seminar Student Evaluations (ICES scale: 1 poor - 6 excellent) Course content: 4.9 Instructor: 4.8 Course in general: 4.8
Spring 1996	Taught one week *Computer Ethics* @ UNM section of a new five week introductory class on computing at UNM (CS101). Did this two times.

ii. Specialized

Fall 2016	*Learning Analytics Research Group (TLTC 708)* – 1 credit, 3 students, 20 participants
Spring 2016	*Learning Analytics Research Group* – 0 credits, 30 participants
Fall 2015	*Learning Analytics Reading Group* – 0 credits, 20 participants
Spring 2015	*Learning Analytics Reading Group* – 0 credits, 20 participants
Fall 2003	*Readings in HCI Seminar* (CMSC 838B) – 1 credit, 13 students Student Evaluations (Scale: 0 Poor - 4 Excellent) Course quality: 3.9 Instructor's teaching: 3.8
Fall 2001	*Readings in HCI Seminar* (CMSC 838B) – 1 credit, 12 students Student Evaluations (Scale: 0 Poor - 4 Excellent) Course quality: 3.8 Instructor's teaching: 3.8
Fall 2000	*Readings in HCI Seminar* (CMSC 838B) – 1 credit, 15 students
Fall 1999	*Readings in HCI Seminar* (CMSC 838B) – 1 credit, 6 students
Spring 1999	*Zoomable User Interfaces* (CMSC 838B) – 15 students Student Evaluations (Scale: 0 Poor - 4 Excellent) Course quality: 3.5 Instructor's teaching: 3.2
Fall 1998	*Readings in HCI Seminar* (CMSC 838B) - 1 credit, 9 students Student Evaluations (Scale: 0 Poor - 4 Excellent) Course quality: 4.0 Instructor's teaching: 3.8

F. ADVISING RESEARCH DIRECTION
i. Undergraduate

	Independent Study Advisor:
2013	Andrej Resevic – new Paths to Computer Science course
2012 – 2013	Danny Michaelis – new Paths to Computer Science course
2010 – 2011	Jonathan Speiser Worked on tournament programmer in educational technologies group
2003-2004	Christian Klein Studied effect of animation when scrolling while reading

2000 – 2002	Rob Sherman Customized undergraduate degree in HCI & Law – focused on voting systems
Fall 2001	Steve Betten Visualizations for real-time monitoring
Spring 2000/ Fall 2000	Beth Weinstein Geographical interfaces for digital library for children
Spring 1999	Nuno Pereria End-user customizable systems
Spring 1996	Philip Eckenroth and Mike Tipping Built a 3D modeling system
Fall 1995	Josh Saiz Novel searching techniques in Pad++ (dynamic indicators)

ii. Master's

Thesis Committee:

2005	Julie Staub in Applied Math. Research on Chaum's scheme for encrypted voter receipts.
1999	George Ziets in Psychology. Advisor is Kent Norman. Research is on gauge design for multiple orders of magnitude.

Independent Study Advisor:

2013	Alina Goldman (iSchool) – Motivation in a self-paced computer science course
2012	Adam O'Sullivan – Computer vision for relative phone location
2000	Stephanie Thibeault (Dance Dept.) Technology and dance
1996	Ellen Killion Built a software library access tool in Pad++
1995	Tom Claus Worked on KidPad
1995	Sam Cancilla Shared calendar application in Pad++
1995	David Rogers Tossing for user interfaces
1995	Richard Bleakman Interfaces for teaching genetic algorithms
1995	Tom Claus Worked on Pad++

iii. Doctorate

Dissertation Advisor:

2017	Tak Yeon Lee, Ph.D. (2017) in Computer Science. "Toward Symbiotic Human-AI Interaction Focusing on Programming by Example". **Currently at Adobe Research.**
2016	Adil Yalcin, Ph.D. (2016) in Computer Science. "Towards Rapid, Effective, and Expressive Visual Data Exploration". **Currently founding startup to commercialize his dissertation research - https://keshif.me/.**

2014 Alex Quinn, Ph.D. (2014) in Computer Science. "Crowdsourcing Decision Support: Frugal Human Computation for Efficient Decision Input Acquisition". **Currently Assistant Professor of ECE at Purdue.**

2012 Chang Hu, Ph.D. (2012) in Computer Science. "Crowdsourced Monolingual Translation". **Currently at Microsoft.**

2007 Amy Karlson, Ph.D. (2007) in Computer Science. Research on personal information management. **Winner of Microsoft Graduate Fellowship. Two CHI papers nominated for best paper. Worked at Microsoft Research for several years.**

2006 Bongshin Lee, Ph.D. (2006) in Computer Science. "Interactive Visualization for Trees and Graphs". **Co-first place winner of IEEE InfoVis 2004 Contest. Currently at Microsoft Research.**

2005 Hilary Hutchinson, Ph.D. (2005) in Computer Science. "Children's Interface Design for Searching and Browsing". **Awarded UMD CS Minker Fellowship. Awarded NSF Graduate Fellowship. Currently at Google.**

2005 Bongwon Suh, Ph.D. (2005) in Computer Science. "Image Management Using Pattern Recognition". **Worked at PARC, then at Adobe Research, now Assoc. Prof. at Seoul National University (Korea).**

2003 Lance Good, Ph. D. (2003) in Computer Science. "Zoomable User Interfaces for the Authoring and Delivery of Slide Presentations". **Worked at PARC as researcher for several years, now at Google.**

2003 Juan Pablo Hourcade, Ph.D. (2003) in Computer Science. "User Interface Technologies and Guidelines to Support Children's Creativity, Collaboration, and Learning". **Currently Assoc. Prof. of Computer Science at the University of Iowa.**

1998 Jason Stewart, Ph.D. (1998) in Computer Science at UNM. Research is on collaborative user interfaces for children using Pad++. **Awarded 1995 DEC Fellowship at UNM.**

Dissertation Committee:

2020 Virginia Leigh Byrne (2020) in Education. Advisor is Diane Jass Ketelhut. "The Chilling Effect of Cyberbullying on Women's Social Presence in Online Discussions"

2019 Zhenpeng Zhao (2019) in Computer Science. Advisor is Niklas Elmqvist. "Data-Driven Storytelling for Casual Users"

2016 Uran Oh, Ph.D. (2016) in Computer Science. Advisor is Leah Findlater. "Accessible On-Body Interaction for People with Visual Impairments"

2016 Kotaro Hara, Ph.D. (2016) in Computer Science. Advisor is Jon Froehlich. "Scalable methods to collect and visualize sidewalk accessibility data for people with mobility impairments"

2014 Aaron Dinin, Ph.D. (2014) in English. Advisor is Martha Nell Smith. "Hacking Literature: A Study in the Technology of Language."

2014 Brian Danielak, Ph.D. (2014) in College of Education. Advisor is Andy Elby. "How Electrical Engineering Students Design Computer Programs."

2013 Irene Eleta Mogollon, Ph.D. (2013) in iSchool. Advisor is Jen Golbeck. "Multilingual use of Twitter: Language Choice and Language Bridges in a Social Network."

2013 John Alexis Guerra Gomez, Ph.D. (2013) in Computer Science. Advisor is Ben Shneiderman. "Exploring Differences in Multivariate Datasets Using Hierarchies: An Interactive Information Visualization Approach"

2013 Sureyya Tarkan, Ph.D. (2013) in Computer Science. Advisor is Ben Shendierman. "Interactive Visual Displays for Results Management in Complex Medical Workflows"

2010 Taowei David Wang, Ph.D. (2010) in Computer Science. Advisor is Ben Shneiderman. "Interactive Visualization Techniques for Searching Temporal Categorical Data"

2009 Jerry Fails, Ph.D. (2009) in Computer Science. Advisor is Allison Druin. "Mobile Collaboration for Young Children"

2008 Chunyuan Liao, Ph.D. (2008) in Computer Science. Advisor is Francois Guimbretiere. "PapierCraft: A New Paper-Based Interface To Support Interaction With Digital Documents"

2008 Aleks Aris, Ph.D. (2008) in Computer Science. Advisor is Ben Shneiderman. "Visualization & Exploring Networks Using Semantic Substrates"

2008 Adam Perer, Ph.D. (2008) in Computer Science. Advisor is Ben Shneiderman. "Integrating Statistics and Visualization to Improve Exploratory Social Network Analysis"

2008 Walky Rivadeneira, Ph.D. (2008) in Psychology. Advisor is Kent Norman. "Tag Clouds: How Format and Categorical Structure Affect Categorization Judgement"

2007 Matthias Mayer, Ph.D. (2007) in Dept. Informatik, Universität Hamburg where I was an outside reader. Advisor is Prof. Dr. Arno Rolf. "Visualizing Web Sessions".

2007 Leslie Eugene Chipman, Ph.D. (2007) in Computer Science. Advisor is Allison Druin. "Collaborative Technology for Young Children's Outdoor Education".

2006 Haibin Ling, Ph.D. (2006) in Computer Science. Advisor is David Jacobs. "Techniques for Image Retrieval: Deformation Insensitivity and Automatic Thumbnail Cropping".

2005 Jinwook Seo, Ph.D. (2005) in Computer Science. Advisor is Ben Shneiderman. "Information Visualization Design for Multidimensional Data: Integrating the Rank-By-Feature Framework with Hierarchical Clustering".

2005 Jen Golbeck, Ph.D. (2005) in Computer Science. Advisor is Jim Hendler. "Computing and Applying Trust in Web-Based Social Networks".

2003 Harry Hochheiser, Ph.D. (2003) in Computer Science. Advisor is Ben Shneiderman. Research on interfaces for time-series data.

2002 Jenny Sterling, Ph.D. (2002) in Music. Advisor is Laszlo Payerle. Research on educational software she developed to teach undergrad music form. She won the campus award on educational technologies from the Center for Teaching Excellence.

2001 Mike Beynon, Ph.D. (2001) in Computer Science. Advisor is Joel Saltz. Research on filter-based programming model for grid computing.

2001 Angela Boltman, Ph.D. (2001) in Education, Advisor is Allison Druin. Research on KidPad's effect on children's storytelling.

2001 Jeff Heflin, Ph.D. (2001) in Computer Science. Advisor is Jim Hendler. Research on the semantic web.

2001 Egemen Tanin, Ph.D. (2001) in Computer Science. Advisor is Ben Shneiderman. Research on browsing large online databases using exploratory overviews.

2000 Vasanth Philomin, Ph.D. (2000) in Computer Science. Advisor is Larry Davis. Research on real-time computer vision for in-car navigation and warning systems.

2000 Byoung-Kee Yi, Ph.D. (2000) in Computer Science. Advisor is Christos Faloutsos. Research on similarity search and data mining in time-sequence databases.

2000 Chris North, Ph.D. (2000) in Computer Science. Advisor is Ben Shneiderman. Research on tight coupling between different visualizations.

1999 Richard Potter, Ph.D. (1999) in Computer Science. Advisor is Ben Shneiderman. Research on pixel data access for end-user customization.

1999 Harald Winroth, Ph.D. (1999) in Computer Science at the Royal Institute of Technology (KTH) in Stockholm, SWEDEN. I was invited to be the *opponent*. Advisor is Jan-Olof Eklundh Research on dynamic projective geometry.

1999 Ismail Haritaoglu, Ph.D. (1999) in Computer Science. Advisor is Larry Davis. Research on real-time computer vision for tracking people.

1999 Zhijun Zhang, Ph.D. (1999) in Computer Science. Advisors are Vic Basili and Ben Shneiderman. Research on perspective-based usability inspection techniques.

1998 Elaine Raybourne, Ph.D. (1998) in Communication and Journalism at the University of New Mexico. Advisor is Ed Rogers. Dissertation is on the use of MUDs for anonymous role-playing to teach about issues of culture, identity, and power.

1998 Fan-Tao Pu, Ph.D. (1998) in Computer Science, Advisor is David Mount. Research on data structures for view-independent 3D object visibility detection.

1998 Eser Kandogan, Ph.D. (1998) in Computer Science, Advisor is Ben Shneiderman. Research on a technique for window management – elastic windows.

1996 Eric Freeman, Ph.D. (1996) in Computer Science at Yale University. Advisor is David Gelernter. "Lifestreams", a computer interface that eliminates the need for filenames by indexing all files and connecting applications to a database.

Proposal Committee:

2019 Maddalena Romano in Geographic Information Systems (City College of New York) Advisor is Carsten Kessler. "Distributed WiFi for Distributed GIS"

2018 Virginia Leigh Byrne in Education. Advisor is Diane Jass Ketelhut. "The Chilling Effect of Cyberbullying on Women's Social Presence in Online Discussions"

2017 Zhenpeng Zhao in HCI. Advisor is Niklas Elmqvist. "A Framework of Media Types for Data-Driven Storytelling"

2012 Irene Eleta in iSchool. Advisor is Jen Golbeck.
"Multilingual Use of Twitter: Language Choice and Language Bridges in a Social Network"

2012 John Alexis Guerra Gómez in Computer Science. Advisor is Ben Shneiderman. "Exploring Differences in Trees by Comparing Structure and Node Value Changes: An Interactive Information Visualization Approach"

2011 Alex Quinn in Computer Science. Advisor is me. "Crowdsourcing Decision Support: Frugal Human Computation for Efficient Decision Input Acquisition"

2011 Sureyya Tarkan in Coputer Science. Advisor is Ben Shneiderman. "Enhancing Timely Management of Workflow with Interactive Visual Displays and Actions for Situation Awareness Processing"

2010 Chris Hayden in Computer Science. Advisors are Mike Hicks and Jeff Foster. "Clear and Correct Runtime Upgrades"

2010 Chang Hu in Computer Science. Advisor is me. "Translation by Collaboration Between Monolinguals"

2008 Walky Rivadeneira in Psychology. Advisor is Kent Norman. "Tag Clouds: How Format and Categorical Structure Affect Categorization Judgement"

2007 Jerry Fails in Computer Science. Advisor is Allison Druin. Research on children's collaborative mobile interfaces.

2005 Haibin Ling in Computer Science. Advisor is David Jacobs. Research on invariance in computer vision.

2001 Jaime Montemayor in Computer Science. Advisor is Allison Druin. Research on physical programming for children.

2001 Harry Hochheiser in Computer Science. Advisor is Ben Shneiderman. Research on interfaces for time-series data.

2001	Angela Boltman in Education. Advisor is Allison Druin. Research on the technology of storytelling.
2000	Jeff Heflin in Computer Science. Advisor is Jim Hendler. Research on knowledge representation on the Web.
1998	Egemen Tanin in Computer Science. Advisor is Ben Shneiderman. Research on query previews.
1998	Thanarat Horprasert in Computer Science. Advisor is Larry Davis. Research on real-time computer vision.
1998	Vasanth Philomin in Computer Science. Advisor is Larry Davis. Research on real-time computer vision.
1998	Chris North in Computer Science. Advisor is Ben Shneiderman. Research on Tightly Coupled Windows.

iv. Post-doc

2009-2012	Tom Yeh working in applied computer vision and HCI (co-mentored with Larry Davis). **Currently at Univ. of Colorado, Boulder.**

4. SERVICE

A. PROFESSIONAL

i. Office and Committee Memberships

2015 – 2018	SIGCHI Adjunct Chair for Awards
2015	TOCHI Special Issue Editor
2015	Learning @ Scale Program Committee
2014	Learning @ Scale Program Committee
2011	CHI 2011 Papers Subcommittee Co-chair
2010	CHI 2010 Papers Subcommittee Co-chair
2005 – 2016	US ACM Committee member
2004 – 2007	SIGCHI Adjunct Chair for US Public Policy Committee
2000	CHI Conference Video Paper Co-Chair
1999	CHI Conference Video Paper Chair
1998	UIST Technical Program Committee
1998	UIST Conference Panel Chair, Technical Program Committee
1998	CHI Conference Video Co-Chair.

ii. Editorial Boards

2015 – 2018	**PeerJ Computer Science**, PeerJ
2012 – 2018	**Transactions on Computer-Human Interaction (TOCHI)**, ACM Press
2007 – 2014	**Foundations and Trends in HCI** (Editor-in-chief), NOW Publishers
2002 – 2016	**Information Visualization**, Palgrave Press

iii. Advisory Boards

2016 – 2018	**Coursera**, Mountain View, CA Coursera Council advisory group
2012 – 2015	**Barrie School**, Silver Spring, MD Board of Trustees for this independent K-12 school
	2013 – 2016: Secretary

2003	**Microsoft Research**, Redmond, WA University Relations Faculty Advisory Board	

iv. Other non-University committees, commissions, panels, etc.

2012	**Judge for Joan Ganz Cooney, National STEM Video Game Challenge**	

vi. Paid Consultancies

2022 – present	**IT Park University** Honorary Rector to help lead new tech educational institution	**Tashkent, Uzbekistan**
2022 – present	**EPAM** Chief Academic Advisor - help with corporate educational programs and creation of new universities	**Newtown, PA**
2020 – 2022	**Logitech** Consultant to help with new product development	**Seattle, WA**
2009 – present	**Consulting as an expert witness** largely for patent infringement cases for a range of clients	**Windsor, MA**
2006 – 2014	**Zumobi, Inc.** Founder of startup company to create mobile information services software	**Seattle, WA**
2008 – 2009	**Microsoft Research** Consultant to help with products related to my research	**Seattle, WA**
2005 – 2009	**Hillcrest Laboratories, Inc.** Advisor to help this start-up develop novel in-home entertainment system	**Rockville, MD**
2003 – 2008	**Windsor Interfaces, Inc.** President and CEO of start-up company to commercialize some HCIL projects	**Chevy Chase, MD**
2005	**ScholarOne, Inc.** Consultant to help them with visualization in their scholarly publication and conference management software	**Charlottsville, VA**
2004 – 2005	**ATTAP, Inc.** Consultant to help this start-up develop novel mobile device interfaces for personal information management	**New York, NY**
2003	**Microsoft Research Corp** On University Relations Faculty Advisory Board	**Redmond, WA**
2001 – 2003	**PARC** Advised on project to support brainstorming	**Palo Alto, CA**
2000	**NASA Goddard Space Flight Center** Designed prototype visualizations for satellite constellation control	**Greenbelt, MD**
1999 – 2001	**Swedish Institute of Computer Science (SICS)** Worked on European Union KidStory project	**Stockholm, Sweden**
1998 – 1999	**Lockheed Martin Astronautics** Advised on use of Pad++ for image analyst application	**Denver, CO**
1996 – 1997	**Sony Research Corporation** Advised on use of Pad++ for product development	**New York, NY**

B. UNIVERSITY
i. Departmental

2013 – 2014	CS Educational Transformation Committee co-chair
2008 – 2012	CS Teaching Evaluation Committee
2008 – 2011	CS Department Council
2007 – 2010	Software Engineering Field Committee chair
2010	UMIACS APT Committee
2009	CS Faculty Search Committee
2007	Chair of APT committee for Evan Golub's promotion to Senior Lecturer
2006	Undergraduate curriculum committee
2006	CS Distinguished Lecturer committee
2004	UMIACS steering committee
2004	High school programming contest
2004	Undergraduate curriculum
2003 – 2005	CS Department Council
2002	CFAR faculty recruiting committee
2001 – 2002	Lab committee
2001 – 2002	On department faculty recruiting committee
2001	Taught 1.5 hour course for high school students in Governor's program.
2000	Represented the computer science department on Capitol Hill for an exhibition to encourage Congressional appropriations for NSF.
2000	Helped with Computer Science Dept. research review day – made departmental demo.
1999 – 2000	Technical staff liaison – to help CS admin and technical staff.
1999	Helped with Computer Science Programming Contest
1996 – 1997	Graduate Admissions coordinator for the UNM Computer Science Department.

iii. University

2016 – 2018	USM Faculty Workload Workgroup
2015 – 2018	DIT Learning Technology Working Group
2015 – 2017	Senate Library Council Committee
2015 – 2018	Senate Educational Affairs Committee
2014 – 2018	Provost's Data Policy Advisory Committee
2013 – 2018	USM Academic Transformation Advisory Committee
2013 – 2018	Future of Information Alliance brainstorming board
2013 – 2018	DIT Technology Accessibility Committee
2013 – 2014	Journalism Faculty Search Committee
2013 – 2014	Learning @ Technology Working Group for DIT
2012 – 2013	Provost's Commission on Blended and Online Education

2012 – 2013	VP IT/CIO – IT Council
2012	CMNS Distinguished Research Scientist Prize comittee
2011	VP / CIO Search Committee
2010	UMD Campus-Wide Mobile App Programming Contest Chair
2002 – 2005	Advisory board member for MITH (Maryland Institute for Technology and the Humanities)
2000	Served on search committee for new intellectual property manager for Office of Technology Commercialization.
2000	Ran event for Maryland Day – opened lab to children to use KidPad to tell collaborative stories