

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Andrew William Wright

U.S. Patent No.: 10,198,879

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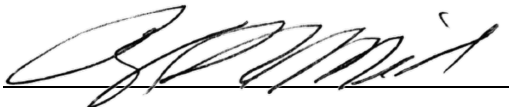
Filing Date: March 9, 2017

Title: METHOD AND SYSTEM FOR LOGGING VEHICLE
BEHAVIOR

DECLARATION OF DR. WILLIAM R. MICHALSON

I hereby 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.

Dated: 28 April 2023

By: 

William R. Michalson, Ph.D.

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I, William R. Michalson of Worcester, Massachusetts, declare that:

I. ASSIGNMENT

1. I have been retained on behalf of United States Automobile Association (“USAA”) to offer technical opinions related to U.S. Patent No 10,198,879 (“the ’879 patent”) (USAA-1001). I understand that USAA is requesting that the Patent Trial and Appeal Board (“PTAB” or “Board”) to institute an *inter partes* review (“IPR”) proceeding of the ’879 patent.

2. I have been asked to provide my independent analysis of the ’879 patent based on the prior art publications cited in this declaration.

3. I am not and never have been, an employee of USAA. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the ’879 patent, the prior art publications cited below, and issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the ’879 patent.

II. QUALIFICATIONS

4. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein.

5. I earned a B.S. from the Syracuse University in 1981, an M.S. and a Ph.D. in Computer Science and Engineering from the Worcester Polytechnic Institute (WPI) in 1985 and 1989, respectively.

6. I am currently a tenured Professor in Robotics Engineering in the Computer Science and Robotics Engineering Department of WPI. At WPI, I perform research and teach in the areas of navigation, communications, and computer system design. I supervised the WPI Center for Advanced Integrated Radio Navigation (CAIRN), where I was developing a Public Safety Integration Center focused on the integration of communications, navigation, and information technologies for public safety applications. Currently I direct the Robot Communication and Navigation Laboratory where my research focuses on the development, testing, and evaluation of systems for both civilian and military applications with a special emphasis on techniques focused on indoor, underground, or otherwise GPS-deprived situations. My interests in communication, navigation, and computing have led me to play an active role in the development of the Robotics Program at WPI, where I teach robotics courses at the graduate and undergraduate level.

7. Prior to joining the faculty of WPI, I worked at the Raytheon Company from 1981-1991, with a leave of absence between 1985-1988 to complete my Doctoral Degree (Ph.D.) in Electrical Engineering from the

Worcester Polytechnic Institute. Prior to my leave of absence, I worked as an Engineer in the Cursive Displays Department and VLSI Design Department of the Computer and Displays Laboratory within Raytheon's Equipment Division. After receiving my Ph.D., I returned to the Equipment Division of the Raytheon Company where I was promoted to a title of Engineer, Design and Development. I was subsequently selected to sit on the engineering staff of the newly-formed System Engineering Department of the Division's Computer and Displays Laboratory. In this capacity, I acted primarily as a consultant to other departments within the laboratory, and my responsibilities ranged from leading the hardware and software development of supercomputer-class computer systems to performing applied research into the exploitation of new technology.

8. I have more than 40 years of experience in the field of computer technology, specifically in the specialized field of signal and data processing. I have consulted and served, including being qualified by courts, as an expert for numerous patent cases, including in patent cases involving motion sensing, positioning, map navigation technologies, and wireless communications a listing of which is set forth in my current curriculum vitae which is attached to this Declaration as Appendix A. I hold a commercial General Radio Operator's license (with Ship RADAR Endorsement), an Extra Class Amateur Radio operator's license, and have held a Commercial Radiotelegraph Operators license. I was first

licensed as a Radio Amateur in 1974 and have been involved in the design, implementation, and repair of radio systems, including radio controlled systems, since that time.

9. I have been involved with numerous projects involving the tracking and control of remote objects, including flying objects. Starting with my work at Raytheon Company I was involved with the tracking of aircraft in both military and civilian air traffic control systems. I have worked on the guidance and control systems for multiple missile systems as well as the guidance and tracking systems for fire control systems and on spaceborne systems for tracking ballistic missiles. In my work at WPI, I have been involved with numerous projects related to tracking land, sea, and air vehicles using the GPS and/or inertial guidance systems. Some of this work has involved the use and control of rotorcraft for applications, such as firefighting and landmine detection and destruction.

10. I am a named inventor on nine patents, including patents on map navigation devices, geolocation systems, and high resolution and precision location systems. I have authored, or co-authored, over 100 journal papers and conference publications, including papers and publications regarding positioning and navigation systems and methods. I am also the co-author of a chapter entitled “An Approach for Implementing a Reconfigurable Optical Interconnection Network for Massively Parallel Computers” in Optical Interconnection – Foundations and

Approaches by C. Tocci and H. J. Caulfield Eds., Artech House, 1994. I am currently under contract to write a book tentatively entitled “Radionavigation and the Global Positioning System,” which covers the physical principles upon which radionavigation system are based as well as the hardware and software required to perform navigation. At WPI I have taught courses in Sensors, Circuits, and Systems, Digital Circuit Design, Embedded Computing, Computer Architecture, Computer, and Navigation. In addition, I have advised projects involving computer, navigation, and communications for a large variety of applications in the air, on land, and on the sea.

11. I have received numerous awards and recognition for my work, including becoming an Elected Senior Member of the IEEE. In addition, I was awarded the Joseph Samuel Satin Distinguished Fellowship for the 1994-1995 academic year, and the Aldo Miccioli Fellowship from the Raytheon Company’s Equipment Division. I am also a member of the Institute of Navigation, the Royal Institute of Navigation, the American Society of Engineering Educators, The Society of Automotive Engineers, the National Marine Electronics Association, and the National Academy of Inventors.

12. My curriculum vitae, attached as Exhibit A, includes a list of publications on which I am a named author. It contains further details regarding

my experience, education, publications, and other qualifications provide to an expert opinion in connection with this proceeding.

III. SUMMARY OF CONCLUSIONS FORMED

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

- **Ground 1A:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 1-3, 5, 8, 11-13, 19-23, 25, 28-31, 39-44, 46-49, 51, 52, and 54 of the '879 patent are made obvious by Forstall, Rabu, Warren, and Langle2009
- **Ground 1B:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 4 and 24 of the '879 patent are made obvious by Forstall, Rabu, Warren, Langle2009, and Tamir
- **Ground 1C:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 6, 7, 16, 26, 27, and 34 of the '879 patent are made obvious by Forstall, Rabu, Warren, Langle2009, and Balachandran

- **Ground 1D:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 9, 10, 17, 18, and 35-38 of the '879 patent are made obvious by Forstall, Rabu, Warren, Langle2009, and Katayama
- **Ground 1E:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 14, 15, 32, and 33 of the '879 patent are made obvious by Forstall, Rabu, Warren, Langle2009, and Thompson2010
- **Ground 1F:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 40, 50, and 53 of the '879 patent are made obvious by Forstall, Rabu, Warren, Langle2009, and Willis
- **Ground 1G:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 55 of the '879 patent are made obvious by Forstall, Rabu, Warren, Langle2009, and Berkobin

IV. LEVEL OF ORDINARY SKILL IN THE ART

14. I have been informed that a person of ordinary skill in the art (“POSITA”) is a hypothetical person who is presumed to have the skill and experience of an ordinary worker in the field at the time of the alleged invention.

The '879 patent was filed March 9, 2017, and claims priority, via several applications, to GB Pat. App. No. 1021292.6 filed 12/15/2010 ("Critical Date"). Because I do not know at what date the invention as claimed was made, if ever, I have used the Critical Date of the '879 patent as the point in time for claim interpretation purposes. My opinion does not change if the invention date is earlier.

15. Based on my knowledge and experience in the field and my review of the '879 patent and file history, I believe that a person of ordinary skill in the art in this matter would have had at least a Bachelor's of Science Degree (or equivalent) in an academic area emphasizing electrical engineering, computer engineering, computer science, or a related technical field, and about 2-3 years of experience in the field of telematics systems (e.g., familiarity with control and diagnostic systems, navigation systems and wireless communication technology). A greater amount of education, i.e., a doctorate in an academic area emphasizing electrical engineering, computer engineering, computer science, or a related technical field, would compensate for fewer years of work experience. Based on my experiences, I have a good understanding of the capabilities of a POSITA. Indeed, I have taught, mentored, advised, and collaborated closely with many such individuals over the course of my career.

V. LEGAL PRINCIPLES

16. I am not a lawyer and I will not provide any legal opinions in this IPR.

Although not a lawyer, I have been advised that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims.

A. Claim Interpretation

17. I understand that claim terms are generally given their plain and ordinary meaning based on the patent's specification and file history as understood by a person of ordinary skill in the art at the time of the purported invention. 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).

B. Priority

18. I understand that a continuation application is a later-filed application that has the same disclosure (specification and figures) as an earlier filed application to which the later-filed application claims priority. A continuation is

generally entitled to the same priority date as the later-filed application to which it claims priority.

C. Anticipation

19. I understand that a patent claim is invalid as anticipated if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. I also understand that, to anticipate, the reference must teach all of the limitations arranged or combined in the same way as described in the claim. I do not rely on anticipation in this declaration.

20. With respect to inherency, I understand that the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. Instead, the inherent characteristic must necessarily flow from the teaching of the prior art.

D. Obviousness

21. I understand that a patent claim is invalid if the claimed invention would have been obvious to a person of ordinary skill in the field at the time of the purported invention, which is often considered the time the application was filed. Even if all of the claim limitations are not found in a single prior art reference that anticipates the claim, the claim can still be invalid.

22. To obtain a patent, a claimed invention must have, as of the priority date, been nonobvious in view of the prior art in the field. I understand that an

invention is obvious when the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art.

23. I understand that, to prove that prior art or a combination of prior art makes a patent obvious it is necessary to: (1) identify the particular references that, singly or in combination, make the patent obvious; (2) specifically identify which elements of the patent claim appear in each of the asserted references; and (3) explain a motivation, teaching, need, market pressure or other legitimate reason that would have inspired a person of ordinary skill in the art to combine prior art references to solve a problem.

24. I also understand that certain objective indicia can be important evidence regarding whether a patent is obvious or nonobvious. Such indicia include:

- Commercial success of products covered by the patent claims;
- A long-felt need for the invention;
- Failed attempts by others to make the invention;
- Copying of the invention by others in the field;
- Unexpected results achieved by the invention as compared to the closest prior art;

- Praise of the invention by the infringer or others in the field;
- The taking of licenses under the patent by others;
- Expressions of surprise by experts and those skilled in the art at the making of the invention; and
- The patentee proceeded contrary to the accepted wisdom of the prior art.

25. To the extent these factors have been brought to my attention, if at all, I have taken them into consideration in providing my opinions and conclusions.

VI. MATERIALS CONSIDERED

26. My analysis and conclusions set forth in this declaration are based on my educational background and experiences in the field (*see* Section II). Based on my knowledge and experience, I believe that I am considered to be an expert in the field. Also, based on my knowledge and experience, I understand and know of the capabilities of persons of ordinary skill in the field during the early 2000s–2010s, and I taught, participated in organizations, and worked closely with many such persons in the field during that time frame.

27. As part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to persons of ordinary skill in this art during the time before the earliest claimed priority date for the '879 patent; my own knowledge and

experiences gained from my work experience in the field of the '879 patent and related disciplines; and my experience in working with others involved in this field and related disciplines.

28. In addition, I have analyzed the following publications and materials:

- U.S. Patent No. 10,198,879 to Wright (“the ‘879 Patent”) (USAA-1001)
- Excerpts from the Prosecution History of the ‘879 Patent (“the Prosecution History”) (USAA-1002)
- Original Complaint for Patent Infringement in *Auto Telematics Ltd. v. United Services Automobile Association*, 6:22-cv-00474 (W.D. Tex. May 11, 2022) (USAA-1004)
- International Publication No. WO 2010/042545 to Curry et al. (“Curry”) (USAA-1005)
- U.S. Patent No. 7,821,421 to Tamir et al. (“Tamir”) (USAA-1006)
- U.S. Patent No. 6,073,004 to Balachandran (“Balachandran”) (USAA-1007)
- Thompson et al., “Using Smartphones and Wireless Mobile Sensor Networks to Detect Car Accidents and Provide Situational Awareness to Emergency Responders,” *Mobilware 2010, LNICST* 48, pp. 29–42, 2010 (“Thompson2010”) (USAA-1008)

- International Publication No. WO 2007/114716 (“Willis”) (USAA-1009)
- U.S. Patent Application Publication No. 2008/0255888 (“Berkobin”) (USAA-1010)
- Cheng et al., “An Android System Design and Implementation for Telematics Services,” 2010 IEEE International Conference on Intelligent Computing and Intelligent Systems. Vol. 2. IEEE, 2010 (“Cheng”) (USAA-1011)
- U.S. Pat. No. 8,290,480 to Abramson (“Abramson”) (USAA-1012)
- U.S. Pat. No. 8,682,399 to Rabu (“Rabu”) (USAA-1013)
- U.S. Pat. App. Pub. No. 2010/0208070 to Haynes (“Haynes”) (USAA-1014)
- U.S. Pat. App. Pub. No. 2002/0105423 to Rast (“Rast”) (USAA-1015)
- U.S. Pat. App. Pub. No. 2009/0192705 to Golding (“Golding”) (USAA-1016)
- U.S. Pat. No. 7,765,058 to Doering (“Doering”) (USAA-1017)
- European Pat. Pub. No. EP1614585A1 to Christian (“Christian”) (USAA-1018)
- U.S. Pat. No. 5,906,393 to Mazur (“Mazur”) (USAA-1019)

- Richard C. Hunt, “Emerging Communication Technologies in Emergency Medical Services,” Prehospital Emergency Care, 2002; 6:1, 131-136 (“Hunt”) (USAA-1020)
- Kanianthra, Joseph et al., “Enhancing post-crash vehicle safety through an automatic collision notification system” No. 2001-06-0085. SAE Technical Paper, 2001 (“Kanianthra”) (USAA-1021)
- Megalingam R.K. et al., “Wireless vehicular accident detection and reporting system.” 2010 International Conference on Mechanical and Electrical Technology (ICMET 2010) (“Megalingam”) (USAA-1022)
- Farris, P. et al., “General Motors OnStar,” Darden Case No. UVA-M-0659 (2003) (“Farris”) (USAA-1023)
- European Pat. App. Pub. No. EP 1,914,691 to Katayama et al. (“Katayama”) (USAA-1024)
- U.S. Pat. App. Pub. No. 2012/0074770 to Lee (“Lee”) (USAA-1025)
- Linda Null and Julia Lobur, Excerpts from The Essentials of Computer Organization and Architecture (2d ed. 2003) (“Null”) (USAA-1027)

- U.S. Pat. Publication No. 2009/0005975 to Forstall et al.
("Forstall") (USAA-1028)
- Langle, Lonnie, and Ram Dantu, "Are you a safe driver?" 2009
International Conference on Computational Science and
Engineering. Vol. 2. IEEE, 2009 ("Langle2009") (USAA-1029)
- U.S. Pat. Publication No. 2006/0053038 to Warren et al.
("Warren") (USAA-1030)
- U.S. Pat. Publication No. 2007/0027585 to Wulff ("Wulff")
(USAA-1031)
- Mohan, Prashanth et al., "Nericell: rich monitoring of road and
traffic conditions using mobile smartphones," Proceedings of the
6th ACM conference on Embedded network sensor systems, 2008
("Mohan") (USAA-1032)
- U.S. Pat. No. 5,274,560 to LaRue ("LaRue") (USAA-1033)
- Declaration of Nathaniel E. Frank-White re Exhibits USAA-1077
(Ex. A) and USAA-1078 (Ex. B) (USAA-1034)
- Declaration of Nathaniel E. Frank-White re Exhibits USAA-1079
(Ex. A), USAA-1080 (Ex. B), and USAA-1081 (Ex. C) (USAA-
1036)

- U.S. Pat. Publication No. 2012/0014659 to Hugosson (“Hugosson”) (USAA-1037)
- U.S. Pat. Publication No. 2011/0225284 to Savolainen (“Savolainen”) (USAA-1038)
- U.S. Pat. Publication No. 2010/0174449 to Kim (“Kim”) (USAA-1039)
- Zhao, Yilin, “Telematics: safe and fun driving,” IEEE Intelligent systems 17.1 (2002): 10-14 (“Zhao”) (USAA-1041)
- Del Rosso, Christian, “The method, the tools and rationales for assessing dynamic memory efficiency in embedded real-time systems in practice,” 2006 International Conference on Software Engineering Advances (ICSEA'06), IEEE, 2006 (“Christian”) (USAA-1042)
- Wakihara, Masataka, “Recent developments in lithium ion batteries,” Materials Science and Engineering: R: Reports 33.4 (2001): 109-134 (“Wakihara”) (USAA-1043)
- Toledo, Tomer, et al., “In-vehicle data recorders for monitoring and feedback on drivers’ behavior,” Transportation Research Part C: Emerging Technologies 16.3 (2008): 320-331 (“Toledo”) (USAA-1044)

- International Publication No. WO 2010/062899 (“Callopy”) (USAA-1045)
- Zhao, Yilin, “Vehicle Location and Navigation Systems,” Artech House, Boston (1997) (“Zhao1997”) (USAA-1046)
- Conover, Gerald D. “ITS Technology in Automotive—Who's on First?” SAE International (2006): 1-11 (“Conover2006”) (USAA-1047)
- Skog, Isaac, et al., “A versatile PC-based platform for inertial navigation,” Proceedings of the 7th Nordic Signal Processing Symposium-NORSIG 2006. IEEE, 2006 (“Skog2006”) (USAA-1048)
- Work, D. B. & Bayen, A.M., “Impacts of the mobile internet on transportation cyberphysical systems: traffic monitoring using smartphones,” National Workshop for Research on High-Confidence Transportation Cyber-Physical Systems: Automotive, Aviation, & Rail, 2008 (“Work2008”) (USAA-1049)
- Flinchbaugh, B., “Smart Camera Systems Technology Roadmap” Real-Time Vision for Human-Computer Interaction (2005), 285-297 (“Flinchbaugh2005”) (USAA-1050)

- LeBlanc, David J., “Road departure crash warning system field operational test: methodology and results,” Vol. 1: Technical Report, University of Michigan, Ann Arbor, Transportation Research Institute, 2006 (“LeBlanc2006”) (USAA-1051)
- Reddy, Sasank et al., “Determining transportation mode on mobile phones,” 2008 12th IEEE international symposium on wearable computers. IEEE, 2008 (“Reddy2008”) (USAA-1052)
- Zhao, Yilin, “Standardization of mobile phone positioning for 3G systems,” IEEE Communications magazine 40.7 (2002): 108-116 (“Zhao2002B”) (USAA-1053)
- Strömmer, Esko et al., “Ultra-low power sensors with near field communication for mobile applications,” Wireless Sensor and Actor Networks: IFIP WG 6.8 First International Conference on Wireless Sensor and Actor Networks, WSAN’07, Albacete, Spain, September 24–26, 2007. Springer US, 2007 (“Strömmer2007”) (USAA-1054)
- Schott, Christian, et al., “CMOS single-chip electronic compass with microcontroller,” IEEE Journal of Solid-State Circuits 42.12 (2007): 2923-2933 (“Schott2007”) (USAA-1055)

- Liutkauskas, V. et al., “Location based services,” Elektronika ir elektrotechnika 52.3 (2004) (“Liutkauskas2004”) (USAA-1056)
- Ealey, Lance & Luis Troyano-Bermúdez, “Are automobiles the next commodity?” The McKinsey Quarterly 4 (1996): 62 (“Ealey1996”) (USAA-1057)
- Zhao, Yilin, “Efficient and reliable data transmission for cellular-and-GPS-based mayday systems,” Proceedings of Conference on Intelligent Transportation Systems, IEEE, 1998 (“Zhao1998”) (USAA-1058)
- Young, Richard A., “Association between embedded cellular phone calls and vehicle crashes involving airbag deployment,” Proceedings of the First International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design, Vol. 1. No. 2001, University of Iowa, 2001 (“Young2001”) (USAA-1059)
- De Fabritiis, Corrado et al., “Traffic estimation and prediction based on real time floating car data,” 2008 11th international IEEE conference on intelligent transportation systems, IEEE, 2008 (“DeFabritiis2008”) (USAA-1060)

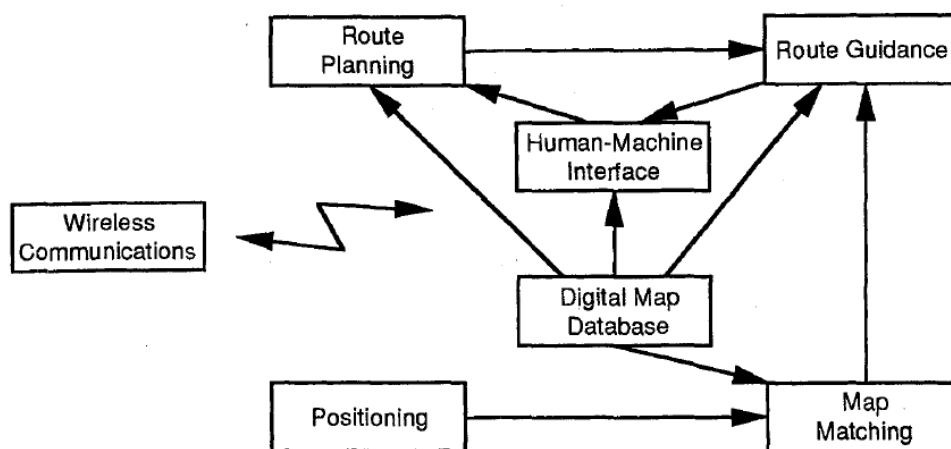
- Schäfer, Ralf-Peter, et al., “A traffic information system by means of real-time floating-car data” (2002) (“Schäfer2002”) (USAA-1061)
- Kerner, B. S., et al., “Traffic state detection with floating car data in road networks,” Proceedings of the 8th International IEEE Conference on Intelligent Transportation Systems, 2005, (“Kerner2005”) (USAA-1062)
- Leduc, Guillaume, “Road traffic data: Collection methods and applications,” Working Papers on Energy, Transport and Climate Change 1.55 (2008): 1-55 (“Leduc2008”) (USAA-1063)
- Troncoso, Carmela, et al, “PriPAYD: privacy friendly pay-as-you-drive insurance,” IEEE Transactions on Dependable and Secure Computing, Vol. 8, No. 5, October 2011 (“Troncoso2011”) (USAA-1064)
- Internet Archive of Waze User Manual (USAA-1077)
- Internet Archive of iPhone User Guide (USAA-1078)
- Internet Archive of iPhone 3G Technical Specification (USAA-1079)
- Internet Archive of iPhone User Guide for iPhone and iPhone 3G (USAA-1080)

- Internet Archive of Instruction Sheet for iPhone 3G (USAA-1081)

29. My analysis and conclusions set forth in this declaration are based on the perspective of a POSITA.

VII. TECHNOLOGY OVERVIEW

30. Techniques for incorporating electronics into vehicles to improve driver experience, including by providing mapping, accident detection and other features, were conventional and well known by the Critical Date. For example, Zhao1997 described the basic modules for performing vehicle location and navigation as early as 1997. USAA-1046, 22-25.



USAA-1046, 23

Zhao1997 also demonstrates that there was consumer interest in emergency features, such as the “Mayday” functionality, stolen vehicle recovery, navigation, roadside assistance, and other functions. *Id.*, 27.

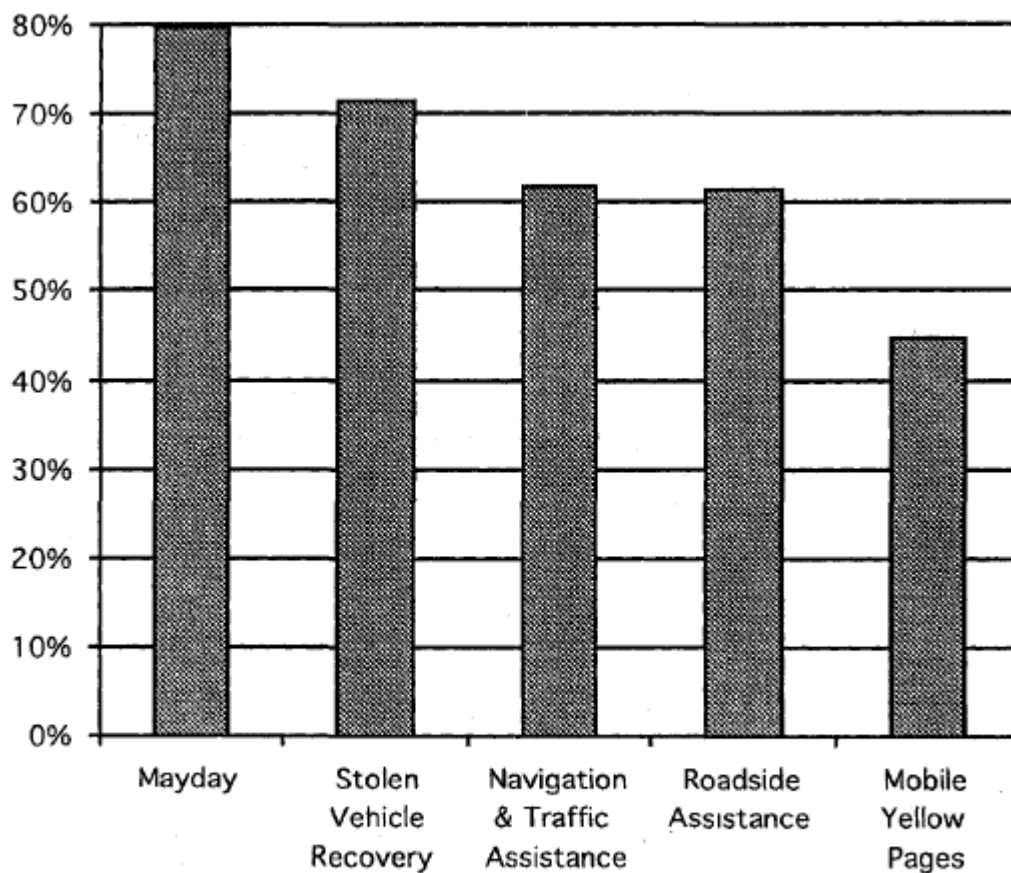


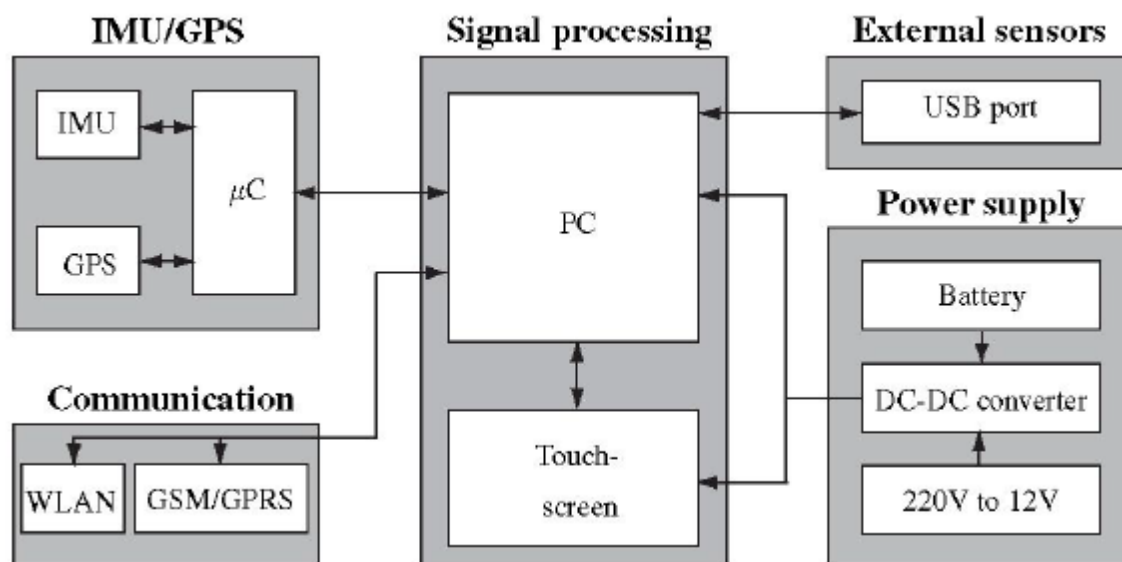
Figure 1.5 American consumer interest in location-based mobile services.

USAA-1046, 25

31. Zhao1997 also described sensing devices for facilitating performing vehicle location and navigation. Examples of sensors include odometers, gyroscopes, compasses, and the Global Positioning System (GPS), which were used for methods to fuse “measurements from multiple sensors to provide both an estimate of the current state of a system and a prediction of the future state of the system. *See id.*, 57-95.

32. By 2006, the early concepts discussed in Zhao1997 were expanded to workers in the field of Intelligent Transportation Systems (ITS). For example, Conover2006 recognized the need to include “navigation, telematics, vehicle dynamics control, parking aids, adaptive cruise control, lane departure warning, active safety systems, predictive safety systems (e.g., braking assist, collision warning, and collision avoidance), and vehicle-to-vehicle and vehicle-to-roadside communications” in automotive systems. USAA-1047, 1.

33. Around 2006, there were also systems being fielded for enabling a portable device with well-known hardware elements (e.g., accelerometers, positioning sensors, touch screen display, processor, memory) to wirelessly communicate with an external server. For example, Skog2006 disclosed a portable system that included the essential elements for determining driver behavior that are used in modern smartphones today. USAA-1048, 1-2.



USAA-1048, Fig. 2

34. In addition to the components internal to the mobile device shown above, the Skog system also had the ability to interface with external sensors to facilitate supplementing the internal sensors with other sources of data. *Id.*, 2-3. This configuration of Skog2006 system is similar to the '879 patent's disclosure that: "[p]referably, the mobile device is arranged to interface with an external device to receive external driving information from said external device. It will be appreciated that the sensor set onboard the mobile device may be supplemented by a sensor set external to the mobile device." USAA-1001, 9:57-61.

A. Sensors

35. The sensors used in the '879 patent include, for example, image sensors, audio sensors, accelerometers, a positioning module (e.g., GPS receiver, inertial measurement unit). These sensors are used to detect the driving behavior of

the operator of a vehicle. As discussed in Section X, these sensors were described in several prior art references that render the claims of the '879 patent obvious. *See, generally* USAA-1005; USAA-1007; USAA-1008; USAA-1011; USAA-1013; USAA-1028; USAA-1029; USAA-1030; USAA-1031; USAA-1032.

36. Additionally, by the Critical Date, several types of mobile devices existed for performing the types of sensing capabilities described in the '879 patent. By 2008, the literature often referred to mobile devices as “smartphones” and these devices included all of the sensing features described in the '879 Patent. USAA-1049, 1. Work2008 is one example that included the following description:

37. Smartphones such as the Nokia N96 now include a video camera, numerous sensors (accelerometers, light sensors, GPS, microphone), wireless communication outlets (GSM, GPRS, WiFi, Bluetooth, infrared), computational power and memory. This phone can be used to listen to the radio, to watch digital TV, to browse the internet, to do video conferencing, to scan barcodes, to read pdfs, etc. The rapid penetration of GPS in smartphones is enabling device geopositioning and context awareness, which in turn is causing an explosion of Location Based Services (heavily relying on mapping) on the devices. USAA-1049, 1.

1. *Image Sensors*

38. The '879 patent describes use of image sensors, such as a camera: “[p]referably, the sensor set comprises an image sensor such as a camera[,]” and “the corresponding sensor data may comprise images and/or a sequence of images generated from the image sensor.” USAA-1001, 8:32-35.

39. By the Critical Date, cameras were ubiquitous on devices such as hand-held mobile phones. For example, in 2005, Flinchbaugh²⁰⁰⁵ included the following description:

Perhaps the single trend with the most far-reaching implications yet to be comprehended is the embedding of smart cameras in wireless phones. This trend began almost instantaneously in 2003 when the number of cellular camera phones exceeded the number of digital still cameras sold.”

USAA-1050, 5. Further, around this time, “[c]ellular phones with digital still camera, digital video recording, and interactive videoconferencing features [were] rapidly evolving.” *Id.*, 8.

40. In 2006, LeBlanc²⁰⁰⁶ described an experimental road departure crash warning system that used a camera similar to those found in cellular telephones to detect when a vehicle was crossing lanes. LeBlanc²⁰⁰⁶ included the following description:

The forward-looking LDW camera was a small “thumb” camera mounted inside the cabin near the top of the windshield just to the passenger side of the rear-view mirror. The camera was mounted behind a composite shroud to reduce reflections and to discourage tampering by the participants.

USAA-1051, 37. The reference also described monitoring lane position:

The LDW alerts were issued when the lane position of the vehicle at some point in the near future was expected to exceed a threshold. The threshold was modulated to reflect both the driver’s selection of sensitivity for the LDW, as well as the presence of currently- or previously-observed objects alongside the original lane of travel.

Id., 44. Based on these descriptions, both the addition of cameras to cellular telephones and the use of such cameras inside a vehicle for detecting driving incidents were well known by the Critical Date.

2. *Audio Sensors*

41. The ’879 patent includes use of audio sensors and, specifically, “[p]referably, the sensor set comprises an audio sensor such as a microphone.” USAA-1001, 9:5-6. However, the Nokia N96 cellular phone (which predates the Critical Date) had a microphone, which would have been understood as a necessity component for the device to operate as a cellular telephone. Indeed, Mohan2008 stated that “[a]ll phones have a microphone that can serve as a readily available sensor.” USAA-1032, 10.

42. Indeed, by 2008, Mohan2008 described a Nericell system that was “a system that performs rich sensing by piggybacking on smartphones that users carry with them in normal course.” *Id.*, 1. It also described that “Nericell uses honk detection to identify noisy and chaotic traffic conditions like that at an unregulated intersection.” *Id.* Based on these descriptions, the addition of a microphone to a cellular phone, and the use of such microphones inside an automobile to detect traffic conditions or incidents was well known by the Critical Date.

3. *Accelerometers*

43. The '879 patent describes use of accelerometers:

The accelerometer 23 is arranged to provide information regarding the motion of the automobile 3 along all three dimensional axes. For example, the accelerometer 23 provides information regarding the pitch, yaw and roll of the automobile 3. Sensor data captured from the accelerometer 23 may be used to determine the g-forces the automobile has been subjected to.

USAA-1001, 15:63-16:2.

44. By the Critical Date, mobile devices, such as smartphones, were known to contain multi-axis accelerometers. For example, in the Nericell system described in Mohan2008, “[a] phone might include any or all of a microphone, camera, GPS, and accelerometer, each of which could be used for traffic sensing functions.” USAA-1032, 1. As another example, Reddy2008 described a system

that used “the Nokia N95 for [] data collection, which contains a three-axis accelerometer with a sensitivity of $\pm 2G$ and bandwidth of 35 Hz and a built-in GPS receiver that can sample at 1 Hz.” USAA-1052, 2. This mobile phone was used “to determine the transportation mode of an individual – whether the user is stationary, walking, running, biking or in motorized transport.” *Id.*, 1. Based on these descriptions, both the addition of accelerometers to cellular telephones and the use of such accelerometers inside a vehicle for detecting driving incidents were well known by the Critical Date.

4. *Positioning Devices*

45. One of the sensors identified in the '879 patent specification is a positioning module. The specification provides two examples of a positioning module, one using the Global Positioning System (GPS) and another using positioning techniques based on cell towers. It includes the following description:

Preferably, the sensor set comprises a positioning module arranged to determine the position of the mobile device. The positioning module may comprise a GPS module. The positioning module may be arranged to utilise the wireless telecommunication module to self-localise, for example by determining a position relative to one or more mobile telecommunication cell tower.

USAA-1001, 9:10-16. Additionally, “the corresponding sensor data may comprise latitude, longitude, elevation, speed and other data obtainable from positioning

modules such as GPS modules as is known in the art.” *Id.*, 9:20-23. The ’879 patent admits that such positioning modules were already known in the art.

46. By the Critical Date, multiple technologies were known to determine the position of a mobile device. For example, by 2002, Zhao2002B described several techniques for determining the location of a mobile phone, including “cell-ID-based, assisted GPS, and TDOA-based methods, such as OTDOA, E-OTD, and A-FLT.” USAA-1053, 1. Zhao2002B recognizes that “[t]here are three most commonly used location technologies: standalone, satellite-based, and terrestrial-radio-based...” including “a typical standalone technology is dead reckoning; a typical satellite-based technology is GPS; and a typical terrestrial radio-based technology is the ‘C’ configuration of the Long Range Navigation (LORAN-C) system.” *Id.*, 2.

47. The addition of positioning modules in cellular telephones and the use of such positioning modules inside a vehicle for detecting driving incidents were well known by the Critical Date. For example, by 2008, Mohan2008 described a system where “[a] phone might include any or all of a microphone, camera, GPS, and accelerometer, each of which could be used for traffic sensing functions.” USAA-1032, 1.

5. *Proximity Sensors*

48. The '879 patent also a registration module to determine if a mobile device is located in a vehicle, and includes the following description:

To this end, the adapter and/or the mobile device may comprise a registration module configured to register the installation of the mobile device to the vehicle and/or the adapter. The registration module may comprise a proximity sensor to detect the proximity of the mobile device to the vehicle. The registration module may comprise a NFC (near field communication) device.

USAA-1001, 3:47-54.

49. By the Critical Date, near-field communications (NFC) were used by mobile devices to communicate with external devices. For example, by 2007, Strömmer²⁰⁰⁷ described that NFC “support[ed] the use of mobile handsets by touch-based interaction, which is an intuitive and user-friendly way of establishing connections and exchanging information between mobile handsets and other devices. USAA-1054, 1-2. Based on these descriptions, the use of proximity sensors were well known by the Critical Date.

6. *Orientation Sensors*

50. The '879 patent describes use of an orientation sensor:

Preferably, the sensor set comprises an orientation sensor for determining the orientation of the mobile device. Said orientation

sensor may comprise an electronic compass for determining a bearing, and so the direction in which the mobile device is facing.

USAA-1001, 9:24-28.

51. The use of orientation sensors in mobile devices were well known by the Critical Date. For example, Schott2007 described the details of an electronic compass suitable for inclusion in a mobile phone and that “[p]ossible host systems for such a miniature complete electronic compass system range from watches to mobile phones to automobiles.” USAA-1055, 11.

B. Accident Detection

52. By the Critical Date, several systems were known to detect vehicular accidents based on data from mobile phones. For example, Liutkauskas2004 described a number of location-based services that could be provided by mobile phones. USAA-1056, 1. Liutkauskas2004 also recognized that:

The most relevant class of Commercial Assistance Services based on wireless location systems is represented by Driver Assistance services. The attention has been focused on breakdown assistance, car accident detection and rescue and car theft recovery.

USAA-1056, 5. Other examples of mobile device accident detection systems included Thompson2010 and Cheng2010, which are discussed in at least Section XI below. *See* USAA-1008, 1-7, Fig. 2; USAA-1011, 1-3, Figs. 4, 5

C. Emergency Response Services

53. Commercial vehicle emergency systems were available by the Critical Date. Examples of such systems included the Ford Motor Company RESCU system and the General Motors OnStar system. These systems were built into vehicles. The interest in providing emergency services for mobile device-based systems were similarly well known by the Critical Date. *See, e.g.*, USAA-1057; USAA-1058; USAA-1059.

D. Mobile Vehicle Monitoring

54. Systems and techniques for monitoring vehicles using a mobile device were well known by the Critical Date. One example is “Floating Car Data” (FCD), which refers to a technique of using data collected from mobile phones to assess/predict driving conditions, driver behavior and insurance adjustments. The interest in using mobile devices for vehicle monitoring was similarly well known by the Critical Date. *See, e.g.*, USAA-1060; USAA-1061; USAA-1062.

E. Insurance Adjustment

55. Systems and techniques for adjusting insurance plans for users based on monitoring vehicle activity were well known by the Critical Date. One example is “Floating Car Data” (FCD), which refers to a technique of using data collected from mobile phones to assess/predict driving conditions, driver behavior and insurance adjustments. Additionally, as discussed in Section X.A.1, Curry

described that driving safety scores can be used by “insurance agencies to determine insurance premiums for related drivers.” USAA-1005, 7:5-22. The interest in using vehicle monitoring to determine and/or adjust insurance was similarly well known by the Critical Date. *See, e.g.*, USAA-1045; USAA-1063.

VIII. OVERVIEW OF THE '879 PATENT

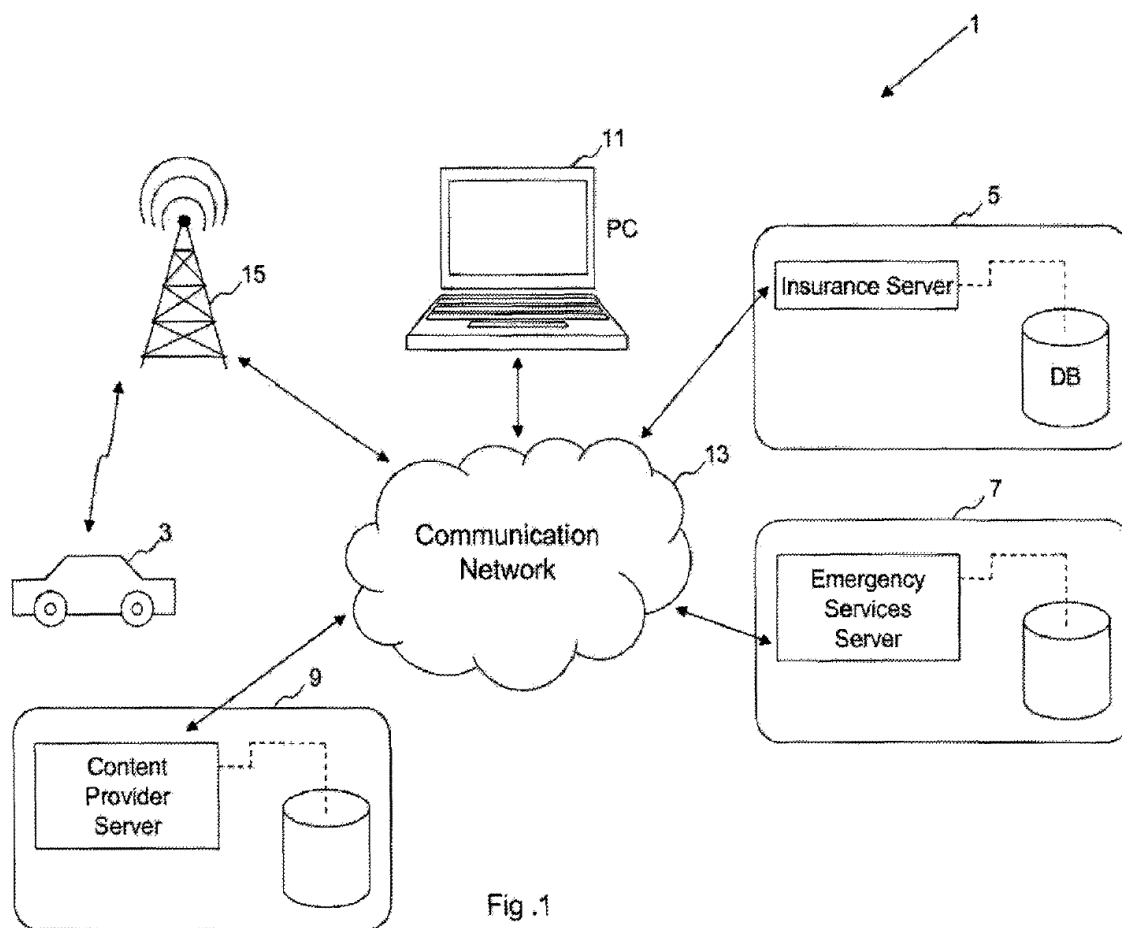
A. Specification

56. The '879 Patent is directed to “methods and systems for logging driving information associated with a vehicle when driven”. USAA-1001, Abstract. A mobile device is “adapted for installation to a vehicle” and logs driving information, such as “video footage associated with how a vehicle is driven.” *Id.*, 1:22-30. The driving information can be used to “determine the cause of an accident,” “modify driver behaviour” or “determine insurance premiums.” *Id.* While the '879 patent purports that “data logging devices for road vehicles are less prevalent,” it otherwise acknowledges that “uptake of data logging devices that can be retrofitted to road conditions” are “known in the art.” *Id.*, 1:49-58. This is consistent with the existence of several well-known vehicle monitoring technologies that were conventional by the Critical Date.

57. Various embodiments described in the '879 patent generally relate to a “mobile telecommunications device adapted for installation to a vehicle and configured to log driving information associated with the vehicle when driven...”

USAA-1001, 1:64-2:14. The device is “loaded with an application,” i.e., a “mobile app,” that is “arranged to record and document events,” such as a “vehicle collision.” *Id.*, 13:9-17. The mobile application is referenced throughout the ’879 patent specification as the “‘Witness’ application.” *See, e.g., id.*, 13:57-63, 23:16-24:67.

58. Figure 1 shows a system 1 placed in automobile 3:



USAA-1001, Fig. 1

59. System 1 includes “a mobile telecommunications device executing the Witness application...” USAA-1001, 13:18-35. The mobile telecommunications device can “communicate with one or more remotely located devices or systems[,]” such as “an insurance server 5, an emergency services server 7, a content provider server 9, and a personal computer 11.” *Id.* The mobile telecommunications device is configured to “monitor and process sensor data” to “derive driving information associated with the moving automobile 3.” *Id.*, 13:36-56. The “driving information” can be used to “determine if a driving incident or event has occurred.” *Id.* The term “driving incident” relates to an “event,” such as “a collision, a near-miss, dangerous driving, erratic driving or similar[,]” or “a means for monitoring a driver's driving performance,” such as “a driving characteristic, or user profile for the subject driver.” *Id.* Additionally, the sensor data and/or the driving information may be used for determinations, such as “if the driver is a cautious driver, or a reckless driver[,]” and “to conduct a risk assessment and to tailor an insurance premium to the subject driver on the basis of a determined driving characteristic.” *Id.*

B. Claims

60. The table below includes identifiers for the '879 patent claims and limitations, which are referenced throughout.

Claim	Identifier	Claim Language
1	[1.1]	A mobile telecommunications device configured to log driving information associated with a vehicle,
	[1.2]	the mobile telecommunications device comprising: a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;
	[1.3]	a user interface;
	[1.4]	a processor; and
	[1.5]	a memory;
	[1.6]	determine, based on at least one of the inputs received by the user interface and sensor data from the device's sensor set, a start of a driving period during which the mobile device is removably attached to the vehicle and the vehicle is in use;
	[1.7]	process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven; and
	[1.8]	store a selection of the driving information to the memory;
	[1.9]	wherein the driving information is derived without data from the vehicle sensors, and
	[1.10]	the mobile telecommunications device is controlled by a downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.
2	[2]	A mobile telecommunications device according to claim 1, wherein the mobile telecommunications device is controlled by the downloaded application to control the mobile device to detect occurrence of a predetermined event and in response take at least one predetermined action.
3	[3]	A mobile telecommunication device according to claim 2, wherein predetermined action is storing driving

Claim	Identifier	Claim Language
		information associated with that event to the memory.
4	[4]	A mobile telecommunication device according to claim 2, wherein predetermined action is storing driving information captured at a higher sampling rate than when an event is not detected.
5	[5]	A mobile telecommunication device according to claim 2, wherein predetermined action is transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system.
6	[6.1]	A mobile telecommunications device according to claim 2, wherein the predetermined action comprises providing feedback to a user to indicate that an event has been detected,
	[6.2]	the mobile telecommunications device being configured to receive a user interaction to confirm or deny whether the detected event has actually occurred following said feedback.
7	[7.1]	A mobile telecommunications device according to claim 6, wherein the feedback comprises notifying a user that a further action has been scheduled, and will be taken within a predetermined period,
	[7.2]	the mobile telecommunications device being further configured to receive a user interaction to confirm or deny whether the further scheduled action should be taken within a predetermined period.
8	[8.1]	A mobile telecommunications device according to claim 2, wherein the predetermined action comprises communicating to a remote system that an event has been detected,
	[8.2]	the mobile telecommunications device being further configured to receive from the remote system a request to transmit to the remote system selected portions of the driving information associated with the detected event.

Claim	Identifier	Claim Language
9	[9.1]	A mobile telecommunications device according to claim 2, wherein the memory comprises: a long term memory for persistently storing driving information and a short term memory for transiently storing driving information,
	[9.2]	wherein the short term memory receives driving information at a higher update rate than the long term memory,
	[9.3]	the mobile telecommunications device being further configured to: write driving information to the short term memory at a predetermined update rate during the driving period in a predetermined sequence; and,
	[9.4]	overwrite the driving information previously written to the short term memory in accordance with the predetermined sequence.
10	[10.1]	A mobile telecommunications device according to claim 9, wherein the mobile telecommunications device is controlled by the downloaded application to control the mobile device to detect an occurrence of a predetermined event and
	[10.2]	in response transfer data from the short term memory to the long term memory.
11	[11]	A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to manage voice-calls incoming to the mobile telecommunications device during a driving period.
12	[12]	A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to enable a hands-free mode of operation on detection of the driving period.
13	[13]	A mobile telecommunications device according to claim 12, wherein the hands-free mode of operation comprises enabling voice-activated commands on the mobile device.

Claim	Identifier	Claim Language
14	[14.1]	A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to detect the occurrence of a predetermined event of significance, such as a crash, and
	[14.2]	in response to store driving information associated with that event to the memory.
15	[15.1]	A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to detect the occurrence of a predetermined event of significance, such as a crash, and
	[15.2]	in response to transmit driving information associated with that event via the wireless telecommunication module to a remote data-logging system.
16	[16]	A mobile telecommunications device according to claim 2, wherein the at least one predetermined action comprises providing the user with options to control the mobile device to take further actions.
17	[17]	A mobile telecommunications device according to claim 1, further configured to: interface with an external device, the external device having access to external driving information associated with a condition of the vehicle; and, to receive at least a portion of the external driving information from the external device.
18	[18]	A mobile telecommunications device according to claim 17, further arranged to interface with the external device wirelessly.
19	[19]	A mobile telecommunications device according to claim 1, wherein the mobile telecommunications device utilizes its own power supply.
20	[20]	A mobile telecommunications device according to claim 1, wherein the mobile telecommunications device is a smartphone.
21	[21.1]	A non-transitory computer readable medium having instructions comprising a software application stored

Claim	Identifier	Claim Language
		thereon, wherein the instructions are configured to be executed on a processor of a mobile telecommunications device to enable the mobile telecommunications device to log driving information associated with a driver of a vehicle,
	[21.2a]	the mobile telecommunications device including a display;
	[21.3]	a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;
	[21.4]	the processor; and
	[21.5]	a memory, wherein the instructions, upon execution by the processor, enable the mobile telecommunications device to:
	[21.2b]	present a user interface on the display;
	[21.6]	determine, based on at least one of the inputs received by the user interface and/or sensor data from the sensor set, a start of a driving period during which the mobile telecommunications device is removably attached to a vehicle and the vehicle is being driven by the driver;
	[21.7]	process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven;
	[21.8]	store a selection of the driving information to the memory; and
	[21.9]	generate a driving score associated with the driver,
	[21.10]	wherein the driving information is derived without data from vehicle sensors.
22	[22]	A non-transitory computer readable medium according to claim 21, wherein execution of the instructions further enables the mobile telecommunications device to detect occurrence of a predetermined event and in response take at least one predetermined action.

Claim	Identifier	Claim Language
23	[23]	A non-transitory computer readable medium according to claim 22, wherein predetermined action is storing driving information associated with that event to the memory.
24	[24]	A non-transitory computer readable medium according to claim 22, wherein predetermined action is storing driving information captured at a higher sampling rate than when an event is not detected.
25	[25]	A non-transitory computer readable medium according to claim 22, wherein predetermined action is transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system.
26	[26.1]	A non-transitory computer readable medium according to claim 22, wherein the predetermined action comprises providing feedback to a user to indicate that an event has been detected,
	[26.2]	the mobile telecommunications device being configured, via execution of the instructions, to receive a user interaction to confirm or deny whether the detected event has actually occurred following said feedback.
27	[27.1]	A non-transitory computer readable medium according to claim 26, wherein the feedback comprises notifying a user that a further action has been scheduled, and will be taken within a predetermined period,
	[27.2]	the mobile telecommunications device being further configured to receive a user interaction to confirm or deny whether the further scheduled action should be taken within a predetermined period.
28	[28.1]	A non-transitory computer readable medium according to claim 22, wherein the predetermined action comprises communicating to a remote system that an event has been detected,
	[28.2]	wherein execution of the instructions further enables the

Claim	Identifier	Claim Language
		mobile telecommunications device to receive from the remote system a request to transmit to the remote system selected portions of the driving information associated with the detected event.
29	[29]	A non-transitory computer readable medium according to claim 22, wherein execution of the instructions further enables the mobile telecommunications device to manage voice-calls incoming to the mobile telecommunications device during a driving period.
30	[30]	A non-transitory computer readable medium according to claim 22, wherein execution of the instructions further enables the mobile telecommunications device to enable a hands-free mode of operation on detection of the driving period.
31	[31]	A non-transitory computer readable medium according to claim 30, wherein the hands-free mode of operation comprises enabling voice-activated commands on the mobile device.
32	[32.1]	A non-transitory computer readable medium according to claim 22, wherein execution of the instructions further enables the mobile telecommunications device to detect the occurrence of a predetermined event of significance, such as a crash, and
	[32.2]	in response to store driving information associated with that event to the memory.
33	[33.1]	A non-transitory computer readable medium according to claim 22, wherein execution of the instructions further enables the mobile telecommunications device to detect the occurrence of a predetermined event of significance, such as a crash, and
	[33.2]	in response to transmit driving information associated with that event via the wireless telecommunication module to a remote data-logging system.
34	[34]	A non-transitory computer readable medium according

Claim	Identifier	Claim Language
		to claim 22, wherein the at least one predetermined action comprises providing the user with options to control the mobile device to take further actions.
35	[35.1]	A non-transitory computer readable medium according to claim 21, wherein the memory comprises: a long-term memory for persistently storing driving information and a short-term memory for transiently storing driving information,
	[35.2]	wherein the short-term memory receives driving information at a higher update rate than the long-term memory,
	[35.3]	wherein execution of the instructions further enables the mobile telecommunications device to: write driving information to the short-term memory at a predetermined update rate during the driving period in a predetermined sequence; and,
	[35.4]	overwrite the driving information previously written to the short-term memory in accordance with the predetermined sequence.
36	[36]	A non-transitory computer readable medium according to claim 35, wherein execution of the instructions further enables the mobile telecommunications device to detect an occurrence of a predetermined event and in response transfer data from the short-term memory to the long-term memory.
37	[37]	A non-transitory computer readable medium according to claim 21, wherein execution of the instructions further enables the mobile telecommunications device to: interface with an external device, the external device having access to external driving information associated with a condition of the vehicle; and, receive at least a portion of the external driving information from the external device.

Claim	Identifier	Claim Language
38	[38]	A non-transitory computer readable medium according to claim 37, further arranged to interface with the external device wirelessly.
39	[39]	A non-transitory computer readable medium according to claim 21, wherein the mobile telecommunications device utilizes its own power supply.
40	[40]	A non-transitory computer readable medium according to claim 21, wherein the mobile telecommunications device is a smartphone.
41	[41]	A non-transitory computer readable medium according to claim 21, wherein the processing step comprises determination of at least one of: vehicle acceleration events and vehicle braking events.
42	[42]	A non-transitory computer readable medium according to claim 41, wherein processing step comprises determination of vehicle swerving events and the determination of such events occurs when data from the sensor set accords with preset parameters.
43	[43]	A non-transitory computer readable medium according to claim 21, wherein the processing step comprises determination of both vehicle acceleration events and vehicle braking events.
44	[44]	A non-transitory computer readable medium according to claim 43, wherein processing step comprises the determination of vehicle swerving events and the determination of such events occurs when data from the sensor set accords with preset parameters.
45	[45.1]	A non-transitory computer readable medium according to claim 21, wherein the mobile telecommunications device further comprises a proximity sensor and

Claim	Identifier	Claim Language
	[45.2]	the instructions, upon execution by the processor, enable the mobile telecommunications device to detect the proximity of the mobile telecommunications device to the vehicle.
46	[46.1]	A mobile telecommunications device configured to log driving information associated with a vehicle,
	[46.2]	the mobile telecommunications device comprising: a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;
	[46.3]	a user interface;
	[46.4]	a processor and;
	[46.5]	a memory;
	[46.6]	the mobile telecommunications device being configured to: determine, based on at least one of the inputs received by the user interface and sensor data from the device's sensor set, a start of a driving period during which the mobile device is removably attached to the vehicle and the vehicle is in use;
	[46.7]	process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven; and
	[46.8]	store a selection of the driving information to the memory;
	[46.9]	wherein the driving information is derived without data from the vehicle sensors and
	[46.10]	the mobile telecommunications device is configured to process the sensor data by determination of at least one of: vehicle acceleration events; and vehicle braking events;
	[46.11]	wherein the determining of such events occurs when data from the sensor set accords with predefined threshold values; and

Claim	Identifier	Claim Language
	[46.12]	wherein the mobile telecommunications device is controlled by a downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.
47	[47]	A mobile telecommunications device according to claim 46, wherein the mobile telecommunications device is configured to process the sensor data by determination of vehicle swerving events and the determination of such events occurs when data from the sensor set accords with preset parameters.
48	[48]	A mobile telecommunications device according to claim 46, wherein the mobile telecommunications device is configured to process the sensor data by determination of both vehicle acceleration events and vehicle braking events.
49	[49]	A mobile telecommunications device according to claim 48, wherein the mobile telecommunications device is configured to process the sensor data by determination of vehicle swerving events and the determination of such events occurs when data from the sensor set accords with preset parameters.
50	[50.1]	A mobile telecommunications device according to claim 46, wherein the mobile telecommunications device further comprises a proximity sensor and
	[50.2]	the mobile telecommunications device is configured, upon execution of the instructions by the processor, to enable the mobile telecommunications device to detect the proximity of the mobile telecommunications device to the vehicle.
51	[51.1]	A non-transitory computer readable medium having instructions comprising a software application stored thereon, wherein the instructions are configured to be

Claim	Identifier	Claim Language
		executed on a processor of a mobile telecommunications device to enable the mobile telecommunications device to log driving information associated with a driver of a vehicle,
	[51.2a]	the mobile telecommunications device including a display;
	[51.3]	a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;
	[51.4]	the processor; and
	[51.5]	a memory, wherein the instructions, upon execution by the processor, enable the mobile telecommunications device to:
	[51.2b]	present a user interface on the display;
	[51.6]	determine, based on at least inputs received by the user interface and sensor data from the sensor set, a start of a driving period during which the mobile telecommunications device is removably attached to a vehicle and the vehicle is being driven by the driver;
	[51.7]	process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven;
	[51.8]	store a selection of the driving information to the memory; and
	[51.9]	generate a driving score associated with the driver,
	[51.10]	wherein the driving information is derived without data from vehicle sensors and comprises the determination of at least one of: vehicle acceleration events; and vehicle braking events;
	[51.11]	wherein the determination of such events occurs when data from the sensor set accords with predefined threshold parameters.
52	[52.1]	A non-transitory computer readable medium according

Claim	Identifier	Claim Language
		to claim 51, wherein the derived driving information may further comprise the determination of vehicle swerving events and
	[52.2]	the determination of such events occurs when data from the sensor set accords with predefined threshold parameters.
53	[53.1]	A non-transitory computer readable medium according to claim 51, wherein the mobile telecommunications device further includes a proximity sensor, and
	[53.2]	the instructions, upon execution by the processor, further enable the mobile telecommunications device to detect the proximity of the mobile telecommunications device to the vehicle.
54	[54.1]	A mobile telecommunications device configured to log driving information associated with a vehicle,
	[54.2]	the mobile telecommunications device comprising: a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;
	[54.3]	a user interface;
	[54.4]	a processor and;
	[54.5]	a memory;
	[54.6]	the mobile telecommunications device being configured to: determine, based on at least one of the inputs received by the user interface and sensor data from the device's sensor set, a start of a driving period during which the mobile device is removably affixed to the vehicle and the vehicle is in use;
	[54.7]	process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven; and
	[54.8]	store a selection of the driving information to the memory;

Claim	Identifier	Claim Language
	[54.9]	wherein the driving information is derived without data from the vehicle sensors, and
	[54.10]	the mobile telecommunications device is controlled by a downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.
55	[55.1]	A mobile telecommunications device configured to log driving information associated with a vehicle,
	[55.2]	the mobile telecommunications device comprising: a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;
	[55.3]	a user interface;
	[55.4]	a processor and;
	[55.5]	a memory;
	[55.6]	the mobile telecommunications device being configured to: determine, based on at least one of the inputs received by the user interface and sensor data from the device's sensor set, a start of a driving period during which the mobile device is removably affixed to the vehicle and the vehicle is in use;
	[55.7]	process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven,
	[55.8]	the processing involving the use of a neural network on the mobile telecommunications device to determine whether the driving information represents an acceptable or unacceptable driving pattern; and,
	[55.9]	store a selection of the driving information to the memory;
	[55.10]	wherein the driving information is derived without data from the vehicle sensors,
	[55.11]	and the mobile telecommunications device is controlled

Claim	Identifier	Claim Language
		by a downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.

C. Prosecution History

61. During prosecution of the '879 patent, the Examiner rejected the claims over U.S. Pub. Nos. 2010/0030540 ("Choi"), 2010/0157061 ("Katsman"), and 2012/0166583 ("Koonce"). See USAA-1002, 117-36. The prior art and prior art combinations analyzed herein rely on the disclosures from Forstall, Rabu, Langle2009, Warren, Tamir, Balachandran, Katayama, Thompson2010, Willis, and Berkobin, which, in combination, make the Challenged Claims obvious.

IX. INTERPRETATION OF THE '879 PATENT CLAIMS

62. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in a patent claim should be interpreted according to their "ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." 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, if ever, I have used the Critical Date of the '879 patent as the point in time for claim interpretation purposes. My opinion does not change if the invention date is earlier.

X. SUMMARY OF RELEVANT PRIOR ART

A. Ground 1

1. Overview of Forstall

63. Forstall is a January 2009 patent publication generally that describes using a mobile device (e.g., smartphone) with embedded accelerometers and/or positioning sensors for vehicle navigation. USAA-1028, [0004]. The mobile device provides “the ability to provide directions from a point of origin to a destination” and “display[s] a current position on a map as well as deliver navigation instructions based on the current position to route a user to a desired destination.” *Id.* Figure 1 shows an example of a mobile device 100 used for vehicle navigation.

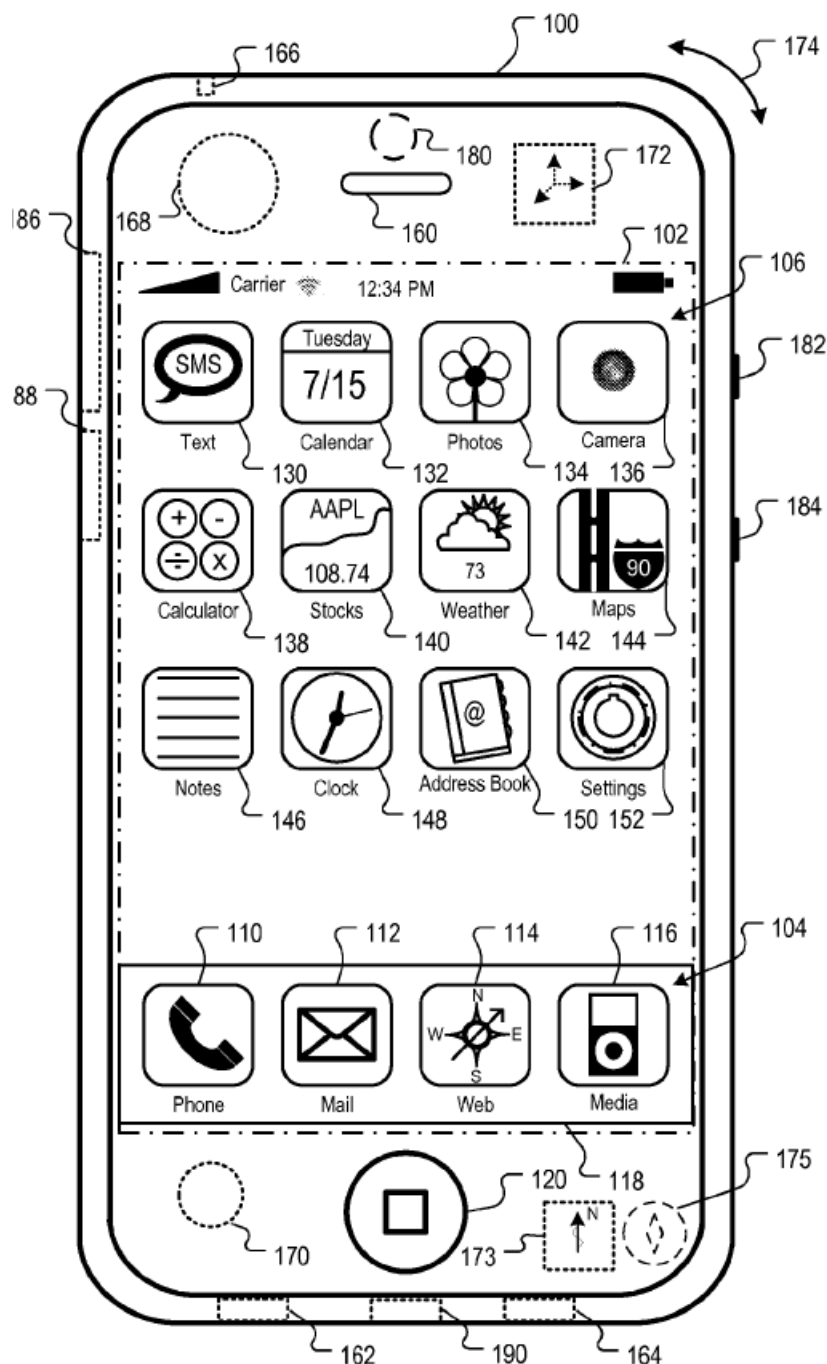


FIG. 1

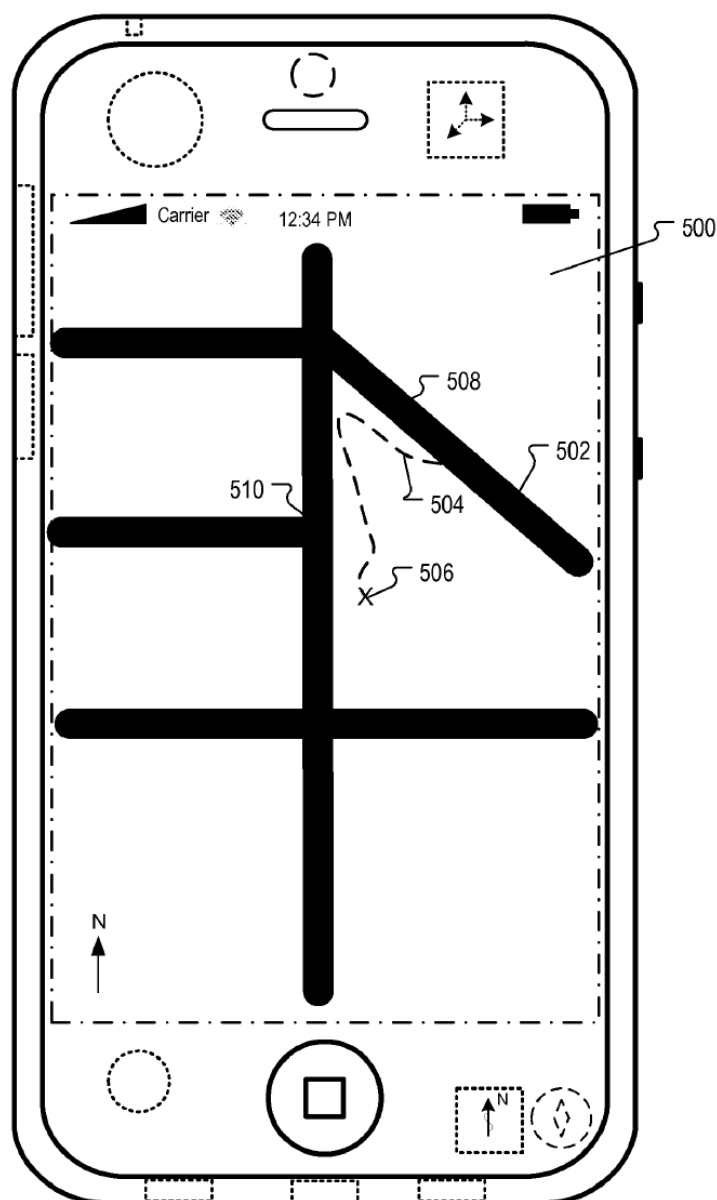
USAA-1028, Fig. 1

64. Device 100 can be implemented as “a handheld computer, a personal digital assistant, a cellular telephone, a network appliance, a camera, a

smartphone,...” among others. USAA-1028, [0024]. The embedded sensors used to “detect motion movement of the mobile device 100” include proximity sensor 168, ambient light sensor 170, accelerometer 172, compass 173, and gyroscope 175. *Id.*, [0036].

65. Device 100 runs a navigation application that “provide[s] navigation information, e.g., map information, location information, route information, and other information.” USAA-1028, [0042]. A user can access the navigation application running on device 100 by interacting with an object presented on a graphic interface. USAA-1028, [0030]-[0033]. For example, in Figure 1, “invoke[s] a map functionality, e.g., by pressing the maps object 144 on the top-level graphical user interface...and has requested and received a map for the location ‘1 Infinite Loop, Cupertino, Calif.’” *Id.*, [0042].

66. The navigation application running on device 100 provides graphical interfaces relating to vehicle navigation. For example, Figure 5 (below) shows an exemplary map display 500 “shows a number of streets and a point of origin ‘O’ 502[,]” and paths “measured by the device 100 from the origin 502 to a destination” (dashed line 504, solid line 508). USAA-1028, [0072].



USAA-1028, Fig. 5

67. Figure 2 (below) illustrates an exemplary network environment enabling the navigation application to obtain data relating to real-time navigation using “one or more services 230, 240, 250, and 260.” USAA-1028, [0042], [0082]. For example, “navigation service 230 can provide navigation information,

e.g., map information, location information, route information, and other information, to the mobile device 100.” *Id.*, [0042]. Additionally, device 100 “communicate[s] with one or more GPS Satellite(s) 252 to enable circuitry and sensors (e.g., a GPS receiver on the mobile device 100) to support a location determining capability.” *Id.*, [0045].

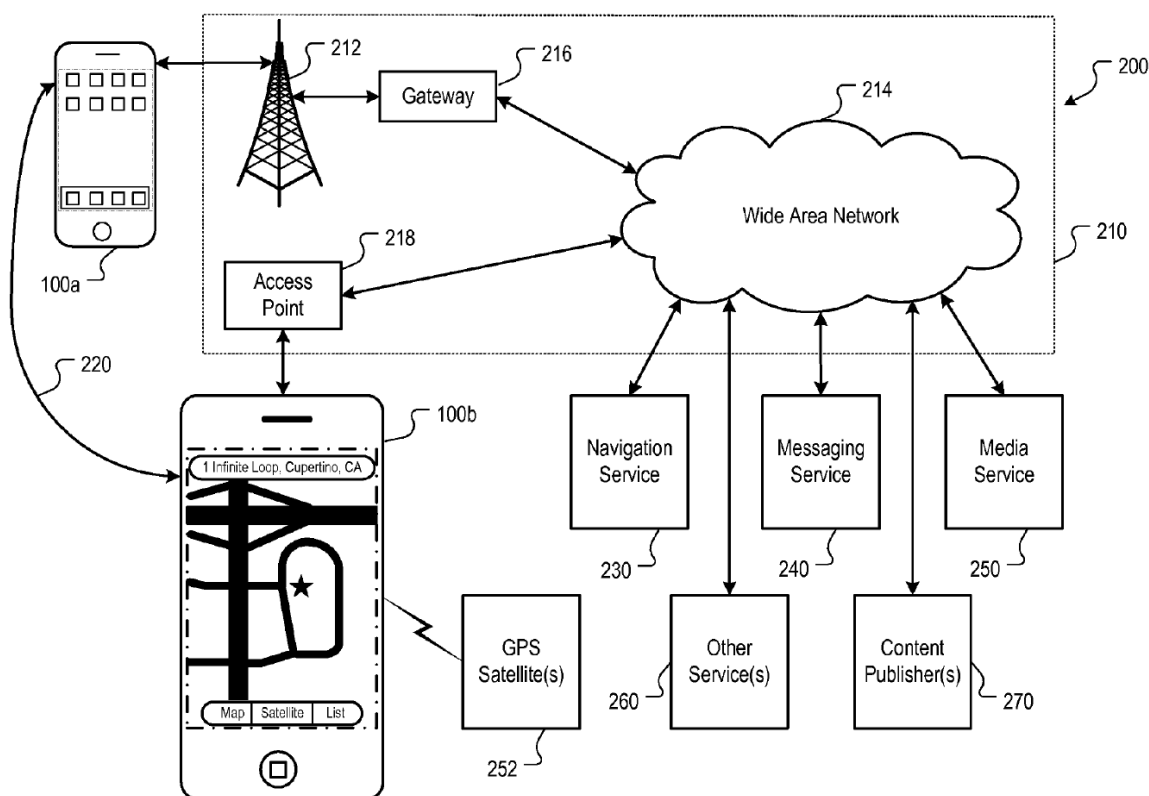


FIG. 2

USAA-1028, Fig. 2

68. Device 100 can use “dead reckoning[,]” where “[s]ensor data from accelerometers, a compass, gyroscopes, and impact sensors can be used alone or in combination” to “measure the movement of device 100 from a point of origin or known location (a ‘fix’) to determine the device’s location relative to the fix.”

USAA-1028, [0062]. Such location measurement techniques are useful “where no satellite or terrestrial positioning signal information is available...” and Forstall teaches configurations device 100 “switch[es] into a dead reckoning positioning mode upon another positioning mode becoming unavailable.” *Id.* In this mode, “an accelerometer reading” is used to “determine how the device [100] is positioned relative to the earth’s gravity[,]” which enables detection of “which direction is down relative to the positioning of the device.” *Id.*, [0070].

69. Device 100 can be set to different modes to selectively adjust the use of dead reckoning functions (e.g., using accelerometer measurements for location measurement). When device 100 is set to a “vehicle mode,” “dead reckoning functions are active” and a “default dead reckoning mode” is used. USAA-1028, [0064]. For example, in vehicle mode, “sudden accelerations in a positive or negative direction along the axis of the earth's gravity are given a reduced importance” for dead reckoning position measurement since “[a]ccelerations along this axis are discounted as they are likely caused by undulations of a traveling Surface and reactions thereto by a vehicle suspension system.” *Id.*, [0070]. In contrast, “[a]ccelerations along the axes perpendicular to the detected gravity axis are given enhanced weight” since “it is primarily these accelerations that contribute to displacement of the vehicle from a known fix to a second position to be measured via dead reckoning and displayed on a map.” *Id.*

70. Another mode of device 100 is “walking mode,” where “a walking mode of dead reckoning position measurement” is used for location measurement, e.g., using data collected by “a footwear impact sensor” and “detecting walking motions” such as “periodic accelerations indicative of steps being taken by a user.” USAA-1028, [0065]. For example, in the “walking mode,” device 100 “combines pedometer functions with compass measurements without use of accelerometer or gyroscope data.” *Id.*, [0071].

2. *Overview of Rabu*

71. Rabu is a U.S. patent issued from a December 2009 application that describes using an accelerometer and/or gyroscope embedded within a “portable media device” (“PMD”) (e.g., “smart phone”) to determine whether the PMD “is in a dock, resting on a surface, or being handled by a person” in addition to whether the PMD “is located in a moving vehicle” or “a stationary vehicle.” USAA-1013, Abstract, 1:1-52, 1:60-2:11, 3:11-28, 6:49-7:6, Figs. 1-8. Those determinations can, for example, be used to “choose a particular mode of operation” for the PMD. USAA-1013, 1:53-59.

72. In more detail, Rabu explains that a PMD “can be a mobile device that includes computing, communication, and/or media playback capabilities” such as a “smart phone,” and that the PMD can be “mounted in a vehicle” using an “automobile dock” or “vehicle holder.” USAA-1013, 3:11-45, Figs. 1, 2. For

example, and as shown in Rabu's Figs. 1-3 (reproduced below), a PMD 100 can be "coupled to dock 200" such that the PMD "is at an angle 302 with respect to the dock." USAA-103, 3:46-50. This angle, which "can be measured by the internal accelerometer and gyroscope of PMD 100," can be referred to as an orientation angle," and the orientation angle can differ "depending on the dock used to mount the PMD." USAA-1013, 3:50-56, 4:15-40. For example, "a dock that is attached to the air vents in a car may hold the PMD in a different orientation angle than a dock that is sitting on a table." USAA-1013, 4:12-14. When the PMD detects that it is at a specific angle, the PMD may determine that it is coupled to a specific dock, "and can switch to an associated mode of operation." USAA-1013, 3:46-4:4. Alternatively, or in addition, the PMD may determine that it is coupled to a dock based on the status of a connection between the PMD and that dock (e.g., a power and/or data connection). USAA-1013, 3:29-45, 8:13-24, Figs. 2, 7.

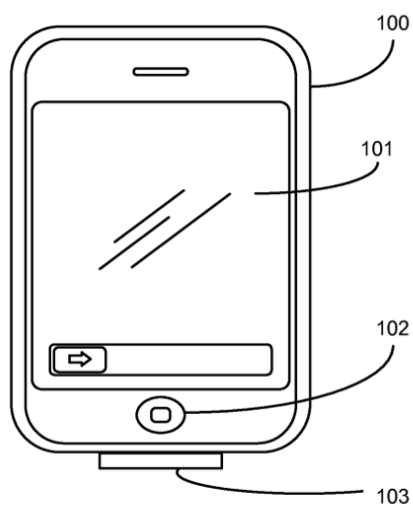


FIG. 1

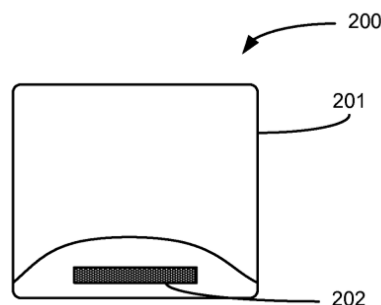


FIG. 2

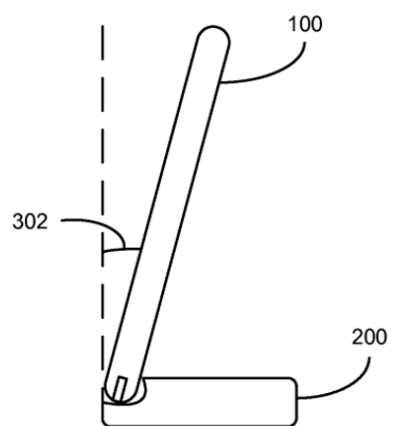
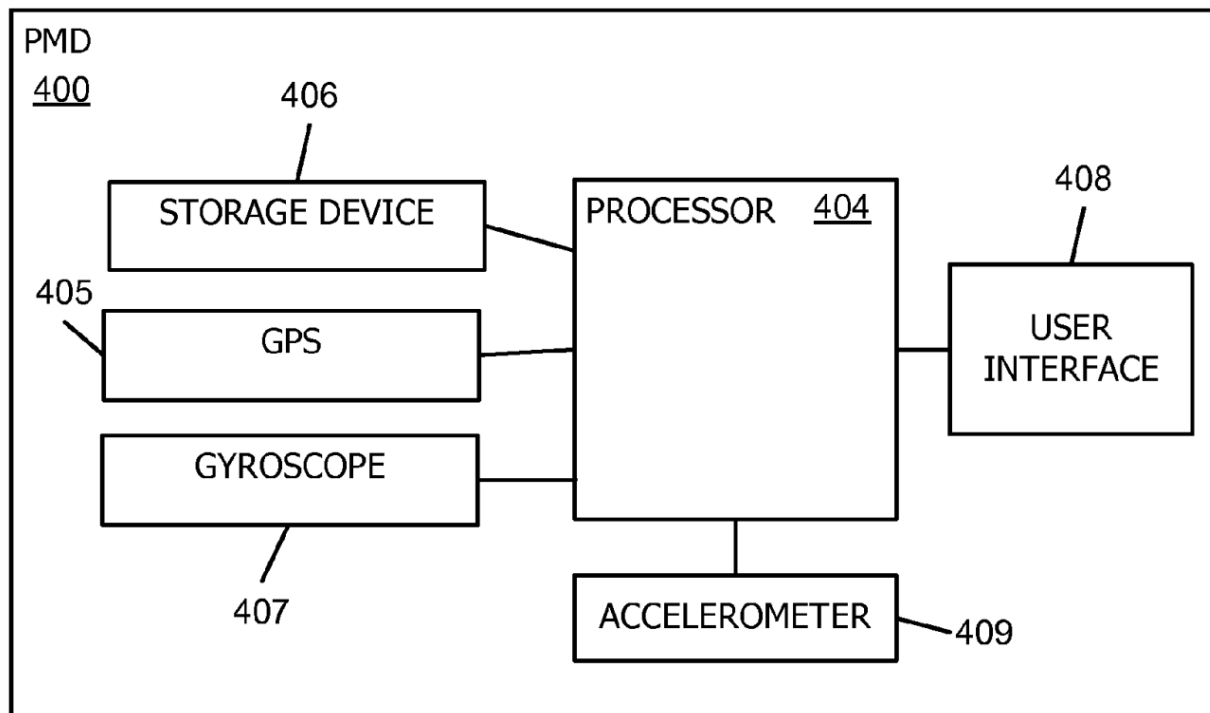


FIG. 3

USAA-1013, Fig. 1

73. As shown in Figure 4 (below), an exemplary PMD “400 can include a processor 404, a user interface 408, an accelerometer 409, a gyroscope 407, a...(GPS) device 405, and a storage device 406, among other components.”

USAA-1013, 4:15-20. Using either or both of the accelerometer and the gyroscope, the PMD’s processor can determine both a motion status and orientation angle of the PMD. USAA-1013, 3:11-28, 4:21-40, Figs. 1, 4.



USAA-1013, Fig. 4

74. For example, a “generally conventional” accelerometer “can measure acceleration due to gravity” and, “[b]ased on that measurement, processor 404 can determine the angle it is tilted at with respect to vertical, horizontal, or any other

reference plane.” USAA-1013, 4:21-29. The same “generally conventional” accelerometer “can sense the amount of dynamic acceleration” and, “[b]ased on this information, processor 404 can determine a frequency spectrum associated with the holder motion and consequently determine the motion status of PMD 400.” USAA-1013, 4:30-33. For instance, “a car travelling at 65 mph will generate a certain frequency spectrum associated with its motion that is distinct from the frequency spectrum generated when that same car is stopped at a signal light,” and “[b]y examining the frequency spectrum for a motion of an object, it can be possible to determine the type of motion being experienced by that object.” USAA-1013, 3:1-10.

75. Based on sensor data obtained from the accelerometer, the PMD’s processor can for example determine whether the PMD is being held by a person in a moving vehicle, or is instead docked in a moving vehicle, and can change the PMD’s mode of operation based on that determination, as shown in Rabu’s Figs. 7 and 8 (reproduced below). USAA-1013, 8:13-10:42. “For example, if the PMD determines that [it] is being held by the driver, the PMD can disable the text messaging feature of the PMD to prevent the driver from sending or receiving text messages while driving.” USAA-1013, 12:26-43.

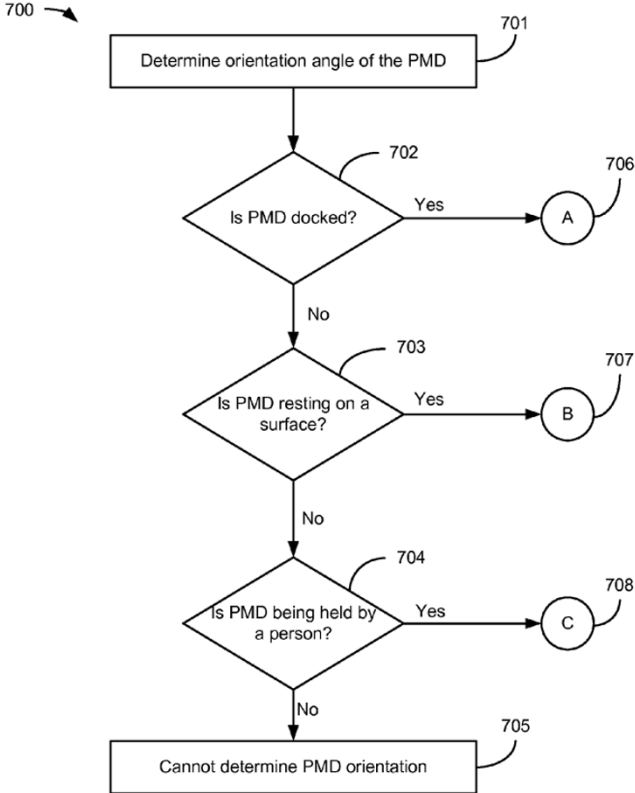


FIG. 7

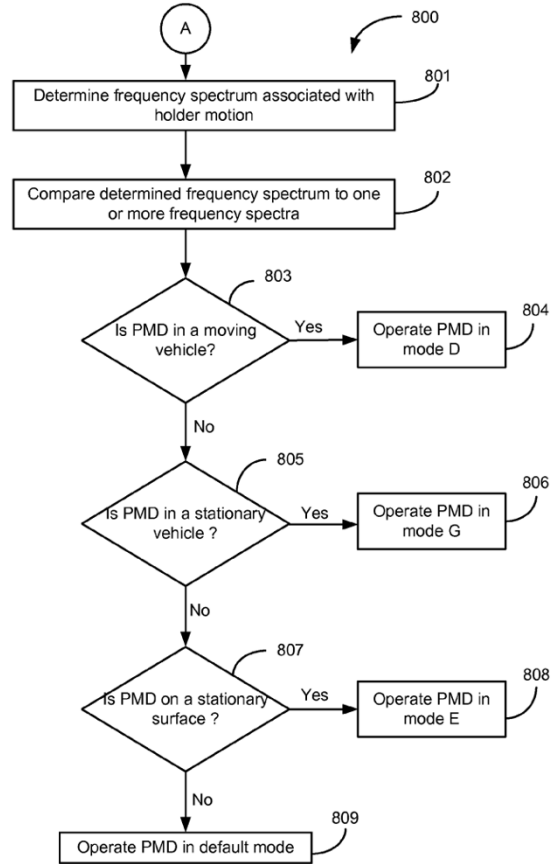


FIG. 8

USAA-1013, Figs. 7, 8

3. Overview of Langle2009

76. Langle2009 is a conference publication focused on using mobile devices to “aid in safe driving practices and detection of emergencies.” USAA-1029, 502. discloses a technique of using a “Google phone” (“T-Mobile G1”) to “classify safe versus unsafe driving[.]” using sensor data collected by the phone, such as “breaking distance, acceleration, and deceleration...” *Id.*

77. Langle2009 recognizes that mobile phones include “embedded accelerometers” that are “used for risk level detection while riding in a vehicle.”

USAA-1029, 502. It also states that “[p]rogramming with accelerometers on the Android platform is straightforward and supports three axes[,]” and thus, “[u]sing accelerometer measurements, it should be possible to classify driving habits as safe or unsafe.” The technique described in Langle2009 “look[s] at the two horizontal axes to determine the safety level of the driver. *Id.*

78. Langle2009 characterizes unsafe driving activity based on driving behaviors, such as braking and lane changing. Figure 2 illustrates acceleration measurements indicative of unsafe acceleration.

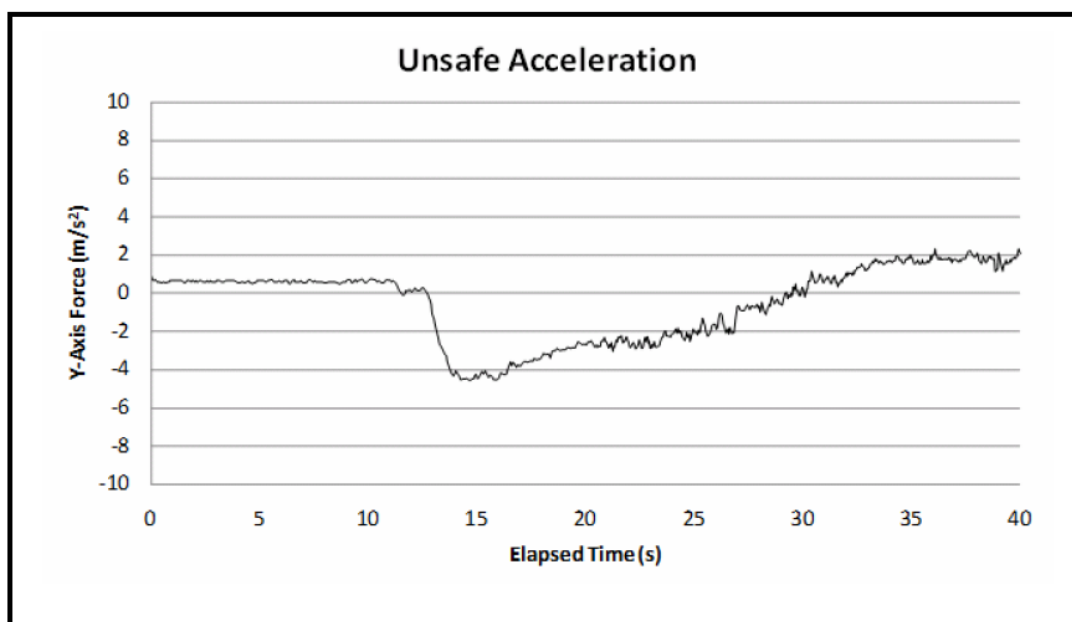


Figure 2. Unsafe Acceleration

USAA-1029, Fig. 2

79. Figure 5 illustrates acceleration measurements indicative of unsafe lane changing.

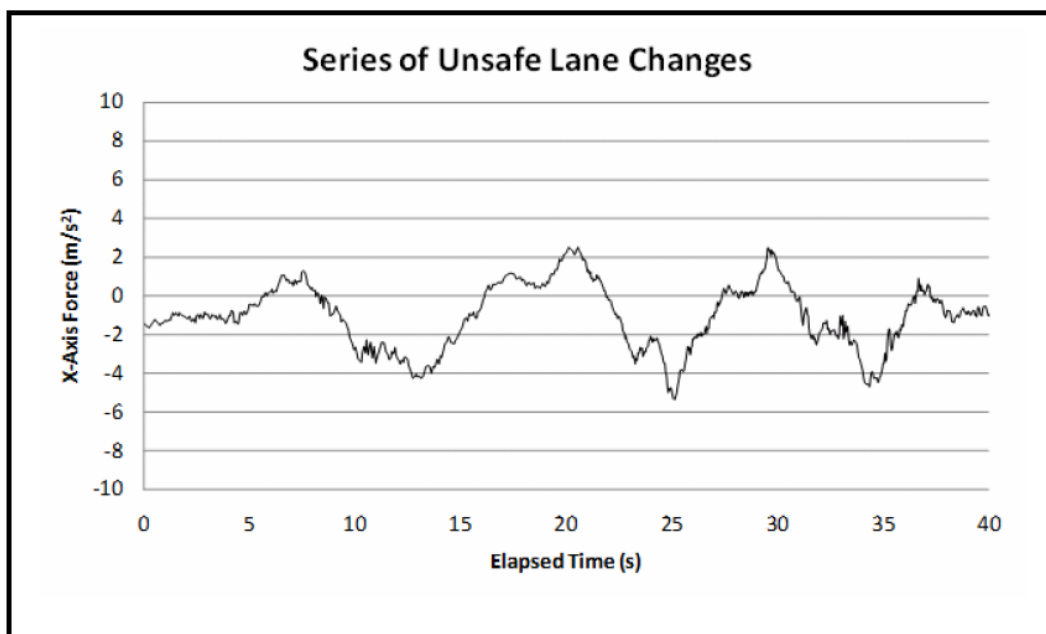


Figure 5. A Series of Unsafe Lane Changes

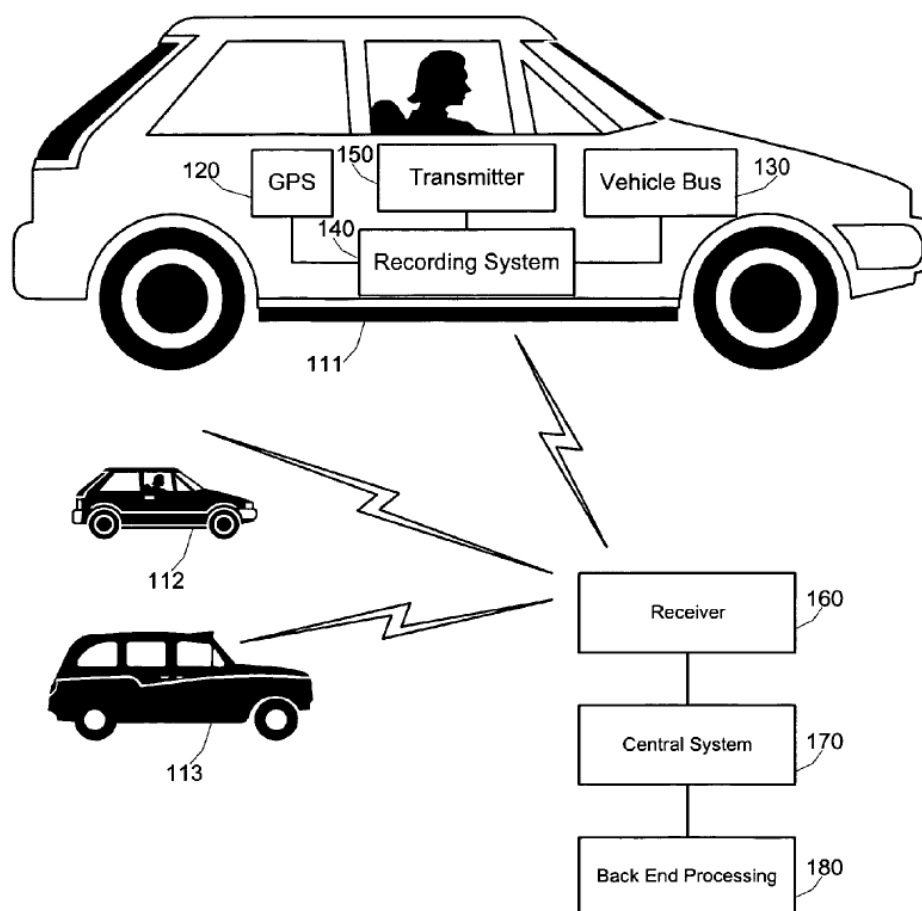
USAA-1029, Fig. 5

4. Overview of Warren

80. Warren is a 2006 U.S. patent publication that describes calculating a “driver score” based on “monitoring vehicle operation[,]” such as “the times the vehicle is operated, the locations the vehicle is operated and the speeds or other characteristics of how the vehicle is operated...” USAA-1030, Abstract. The driver score is “applied to ascertain the risk of insuring a particular driver” and “a tool for defining or adjusting the terms of an insurance policy for an insured driver.” *Id.* This enables “more accurate and profitable insurance policies.” *Id.*

81. Figure 1 shows an exemplary system for collecting vehicle operation data used to compute a driver score. A vehicle 111 is equipped with a vehicle

recording system 140 with interfaces (GPS interface 120, vehicle bus interface 130) for collecting monitoring information, including “speed of the vehicle,” “motion through the use of an accelerometer,” “the location of the vehicle,” and “direction of motion.” USAA-1030, [0020]. The collected information is stored locally information locally and/or transmitted to central system 170. *Id.*



USAA-1030, Fig. 1

82. The driver score “reflects a qualitative view of the driving characteristics for a particular vehicle or a combination of a vehicle and driver,” for example, “a risk level associated with insuring a particular driver.” USAA-1030,

[0024]. Other examples include “the accuracy of information provided to an insurance company,” “compliance of a teenaged driver within guidelines established by his or her parents,” and “compliance of teenaged drivers with local/regional laws...” *Id.* The driver score can also “reflect[] an insurance risk and is used to either increase or decrease an insurance premium or otherwise modify the terms of an insurance policy.” *Id.*, [0026]. As shown in Table 1 (below), driver scores can be computed for different scenarios and used to represent “a risk level associated with insuring a particular driver.” *Id.*, [0024].

TABLE 1

Time of Day	Normal Traffic	Peak Traffic	Risk Traffic	Weighted Score
Risk Factor	0.60	1.40	2.50	
Driver A	20%	75%	5%	1.295
Driver B	80%	20%	0%	0.760
Driver C	20%	20%	60%	1.900
			(capped at 50%)	1.650

USAA-1030, [0028]

5. Overview of Tamir

83. Tamir is a U.S. patent focused on a traffic information system that evaluates driver behavior in a vehicle. USAA-1006, Abstract. It discloses a data collection technique in which “samples are collected at a dynamically adjusted rate[,]” by determining sampling rate “according to the location of the driving...” *Id.*, 9:10-20. For example, data collection can involve “accumulating more samples at areas where there are many accidents or near intersections.” *Id.* The sampling

rate can also be adjusted according to “the time of day, date, and/or external conditions, such as weather conditions,” and “the driving behavior of the vehicle,” e.g., “increasing the sampling rate when reckless driving is identified.” *Id.*; *see id.*, 20:52-21:11.

6. *Overview of Balanchandran*

84. Balachandran is a U.S. patent that describes an emergency response technique focused on “enabling emergency call initiations in response to the detection of a vehicle accident.” USAA-1007, Abstract. The emergency response technique involves an activation signal transmitted between vehicle sensors that detect an accident and a cellular telephone used for an emergency call. *Id.*, 1:34-47. The emergency call activation signal “activates a timer for delaying initiation of an outgoing call to an emergency number, such as 911.” *Id.* Once the timer expires, the cellphone “initiates an emergency call setup to the mobile switching center servicing the telephone unit.” *Id.*, 1:48-67. Further, the cellphone can provide “[a]n audio or visual indication [that] notifies the passengers of activation [a] timer 35 and ceases with expiration or cutoff of the timer.” *Id.*, 2:46-63.

7. *Overview of Katayama*

85. Katayama is a European patent application that describes a “driving recorder” that records “situation data” relevant to driving behavior that indicates the “surrounding situation or the like of a motor vehicle during a certain period

before and after a time of an accident or...risk incident” in which “a driver...is close to [being] involved in an accident...” USAA-1024, [0001], [0011], [0058].

86. Through “after-the-fact analysis” of recorded data the recorder can, for example, determine the cause of an accident. Id., [0001]-[0002]. After-the-fact analysis of recorded data similarly allows for insights into driving behavior that may have contributed to the occurrence of a given “risk incident.” USAA-1024, [0001]-[0002]. Figure 2 (below) shows an external perspective view of an exemplary driving recorder 1.

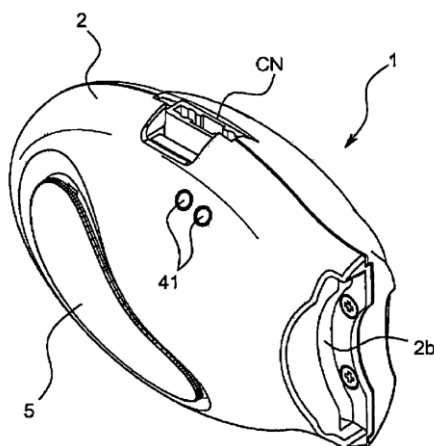
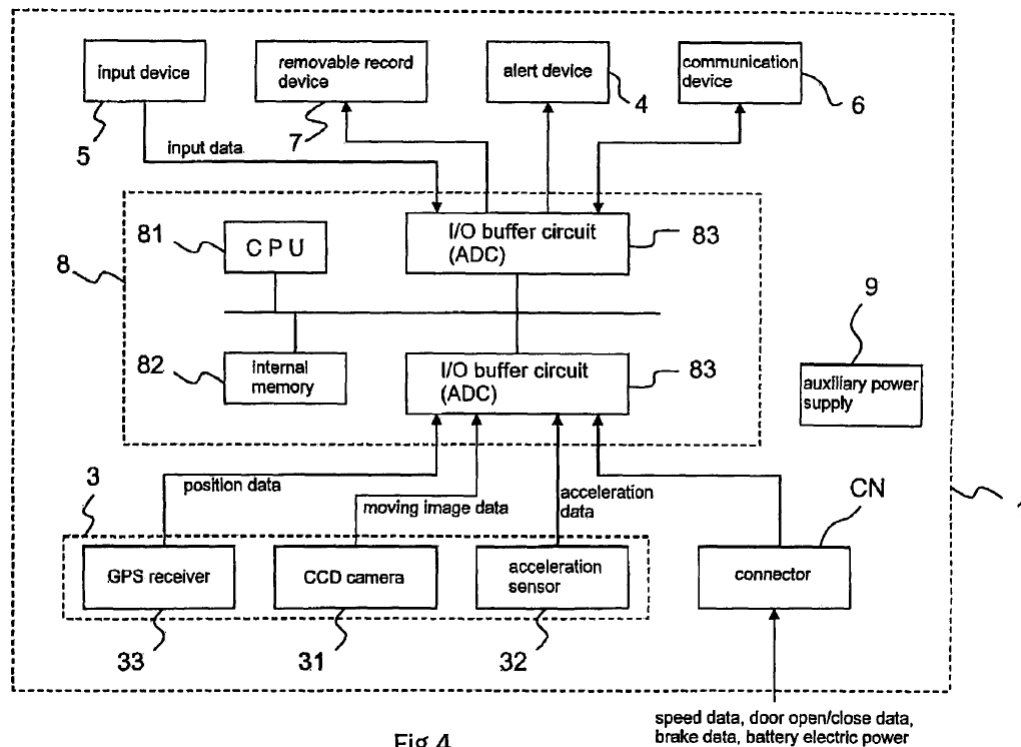


Fig.2

USAA-1024, Fig. 2

87. Recorder 1 detects occurrence of accidents and/or risk incidents based on “situation data” that includes both sensor data and information derived therefrom, including “acceleration data indicating acceleration applied to a vehicle,

position data indicating a position of the vehicle, speed data indicating a speed of the vehicle, brake data indicating whether or not a brake of the vehicle is activated, [and] door open/close data indicating whether a door is open or closed....” USAA-1024, [0013]. Figure 4 (below) depicts components of an exemplary recorder 1, including both internal sensors “CCD camera 31,” “acceleration sensor 32,” and “GPS receiver 33”, and an “internal memory 82” that is configured to store sensor data and related derived information, in addition to programs executed by “CPU 81.” USAA-1024, [0034], [0044].



USAA-1024, Fig. 4

88. Figure 5 (below) is a “functional block diagram” of the same “information processing device” depicted in Figure 4. USAA-1024, [0028],

[0044]-[0045]. “As shown...each device is controlled...by operating the CPU 81 in accordance with programs stored in a predetermined area of the internal memory 82.” Id.

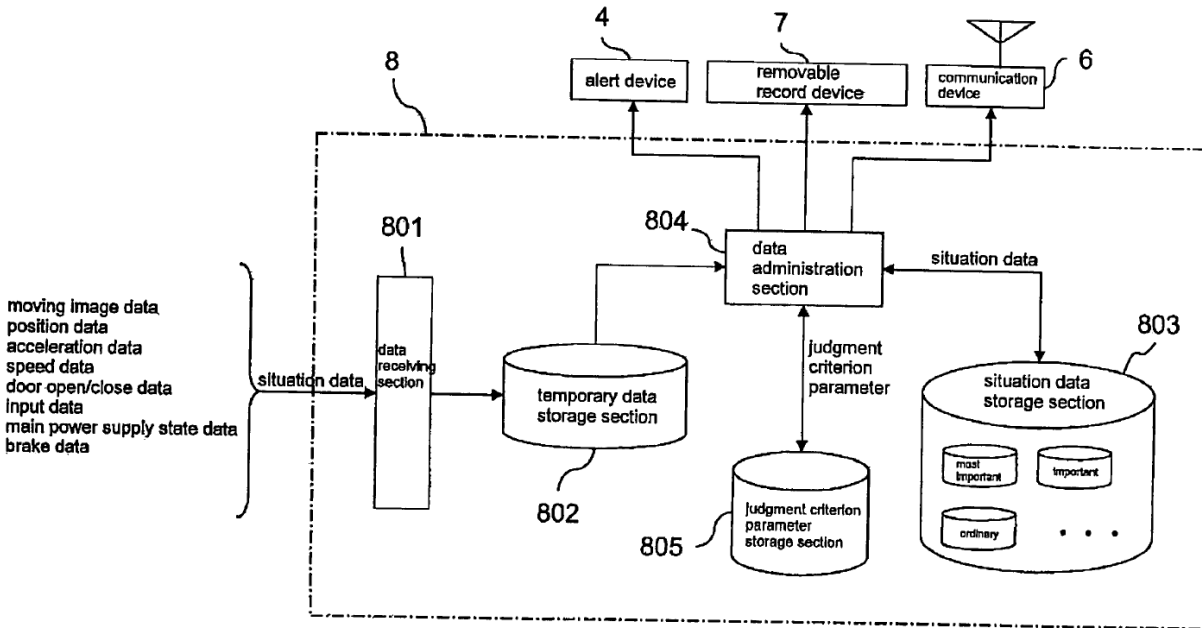


Fig.5

USAA-1024, Fig. 5

89. As described and shown, memory 82 features an architecture divided into multiple sections, including “data receiving section 801,” “temporary data storage section 802,” “situation data storage section 803,” “data administration section 804,” and “judgment criterion parameter storage section 805.” Id., [0044]. In conjunction with this architecture, Katayama describes data handling techniques that enable “effective use” of the memory’s limited capacity such that “important data will not be erased,” and will instead remain available for easy and accurate “after-the-fact analysis” of accidents and/or risk incidents. Id., [0016].

90. In more detail, data receiving section 801 receives “situation data” including sensor data “at a constant sampling time one after another in a chronological order and writes the received situation data” in temporary data storage section 802, which is set in another “predetermined area of the internal memory 82.” Id. Due to that area’s limited capacity, “old data is sequentially erased” and replaced over time with “new situation data.” USAA-1024, [0045], [0016].

91. To avoid erasure of situation data that might be useful in determining the cause of an accident or risk incident, data administration section 804 determines at the “time of recording” whether or not temporarily stored situation data meets one or more predetermined criteria for long term storage. USAA-1024, [0001]-[0002], [0016], [0046]-[0050]. If so, the recorded situation data is for example classified with an identifier marking it as “important,”¹ and then transferred with the identifier from “temporary data storage section 802” to long

¹ Katayama describes a variety of potential categories of classification, with corresponding identifiers for each category; for example, “categories may be specified according to an event that is estimated to have occurred such as...an accident,” according to an “order of importance,” or “in accordance with a combination of the above or other category system.” USAA-1024, [0012]-[0016].

term “situation data recording section 803.” See USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083]. In contrast, situation data that is classified with an identifier marking it as less than important remains in “temporary data storage section 802” until eventually overwritten with new data. See USAA-1024, [0011]-[0016], [0054].

92. Criteria used in determining whether to mark and/or transfer a given set of recorded accelerometer data may include, for example, “whether or not the acceleration” indicated by that data exceeds a “predetermined” threshold, and “whether or not the acceleration continues for more than or equal to a certain period [of time].” USAA-1024, [0047]-[0048]. Accelerometer data meeting either of these criteria may, for example, be marked with a corresponding identifier and transferred to long term storage in “situation data recording section 803.” See USAA-1024, [0011]-[0016], [0027], [0046]-[0050], [0054], [0083].

93. To enable these and other determinations to take place, “the value (the content) of each situation data is, for example, digitalized in accordance with the judgment criterion parameter” or parameters against which it will be compared, and the resulting “digitalized” values are temporarily stored. See USAA-1024, [0047]-[0049]. “[W]hether or not the content of each situation data meets” a “predetermined condition” for marking and/or transfer may then be judged based on logical comparisons between the stored values and the corresponding

parameter(s). USAA-1024, [0049]. For example, “concerning the acceleration,” the predetermined condition may be “satisfied at a time when...both the acceleration data exceeds the predetermined judgment criterion and the acceleration data continues over a certain period [of time].” USAA-1024, [0049].

8. *Overview of Thompson2010*

94. Thompson2010 is a research publication generally focused on smartphone-based accident detection applications. It describes “how smartphones in a wireless mobile sensor network can capture the streams of data provided by their accelerometers, compasses, and GPS sensors to provide a portable ‘black box’ that detects traffic accidents and records data related to accident events, such as the G-forces (accelerations experienced by the driver).” USAA-1008, 30.

Figure 2 shows a smartphone-based accident detection system.

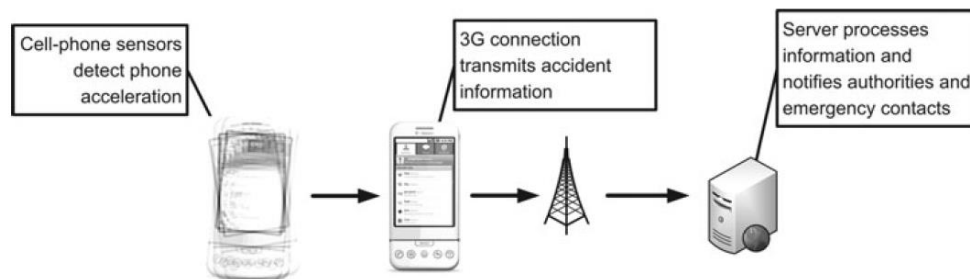


Fig. 2. Smartphone-Based Accident Detection System

USAA-1008, Fig. 2

95. Thompson’s system employs a client-server architecture in which “sensors built into a smartphone detect a major acceleration event indicative of an accident and utilize the built-in 3G data connection to transmit that information to

a central server.” USAA-1008, 30. The server “then processes the information and notifies the authorities as well as any emergency contacts.” *Id.* This client-server architecture is called “WreckWatch,” which a “mobile client/server application [] developed to automatically detect car accidents.” USAA-1008, 30. WreckWatch is “separated into two main components—the WreckWatch server and the WreckWatch client,” as shown in Figure 3.

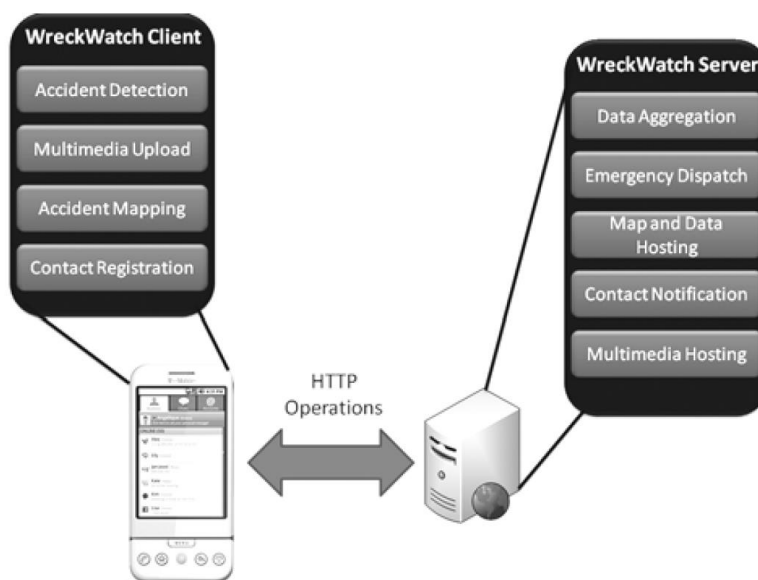


Fig. 3. WreckWatch Architecture Diagram

USAA-1008, Fig. 3

9. *Overview of Willis*

96. Willis is an international application publication generally focused on techniques for “determining the proximity of radio frequency devices using the analysis of a series of receive signal strength indicator (RSSI) values.” USAA-1009, Abstract. Willis recognizes that “RSSI values are used in a range of

situations” and “in various radio frequency technologies including General Packet Radio Service (GPRS), Global System for Mobile Communications (GSM), Code division multiple access (CDMA), Bluetooth™, ZigBee™, Wifi 802.11x, and other Radio Frequency Identification (RFID) methods.” *Id.*, 1:23-27. Wilson discloses an exemplary embodiment “applied to measurement of Bluetooth signal strength from a mobile phone inside a stationary vehicle.” *Id.*, 14:25-15:3. This embodiment “provide[s] a proximity detection of the phone coming within 2 meters of the vehicle in any manner from any direction.” *Id.*

10. Overview of Berkobin

97. Berkobin is a U.S. patent publication generally focused on determining driver behavior based on vehicle operating parameters and adjusting insurance premiums based on the driver behavior. USAA-1010, Abstract. Berkobin also teaches embodiments in which its disclosed techniques “can employ Artificial Intelligence techniques such as machine learning and iterative learning[,]” such as “Bayesian networks, behavior based AI, neural networks, fuzzy systems, evolutionary computation...” *Id.*, [0031].

**XI. [GROUND 1A] – FORSTALL, RABU, LANGLE2009, WARREN
RENDERS CLAIMS 1-3, 5, 8, 11-13, 19-23, 25, 28-31, 39-44, 46-49, 51, 52, 54
OBVIOUS**

98. For the reasons articulated in detail below, and based on my review of the '879 patent, the file history, and the prior art references cited here, it is clear

that a POSITA would have readily understood that the teachings of Forstall, Rabu, Langle2009, and Warren makes the elements of claims 1-3, 5, 8, 11-13, 19-23, 25, 28-31, 39, 41-49, 51, 52, and 54 obvious.

A. Forstall-Rabu-Langle2009-Warren Combination

1. Forstall and Rabu

99. A POSITA would have found obvious integration of Rabu's dock status sensing and associated mode-shifting capabilities into Forstall's device 100, thereby enhancing the device's ability to promote safe driving. As explained below, the result is a device with added functionality, capable of defining and determining different types of driving periods based on user inputs and sensor data (including one in which the phone is docked within a moving vehicle, and another in which the phone is undocked within a moving vehicle). *Id.*

100. For example, the Forstall-Rabu device would leverage orientation and motion data from its accelerometer to determine both vehicle motion and phone docking status upon a user initiating an adaptive navigation period. USAA-1013, 3:1-10, 4:21-33, 8:13-10:42, 15:7-22, Figs. 1, 4-5, 7-8. Consistent with both Forstall and Rabu, the Forstall-Rabu device would provide a basis for changing the operational mode to "vehicle mode," which then enables position measurement using a "default dead reckoning mode." USAA-1028, [0064], [0070]; USAA-1013, 3:1-10, 4:21-33, Figs. 1, 4. For example, a POSITA would have found it

obvious to leverage motion and orientation data from accelerometer 172 to detect whether device should operating in “vehicle mode.” USAA-1028, [0070].

101. As explained in Section X.B.1, Forstall describes techniques for using a mode of device 100 (vehicle mode, walking mode) to select a type of dead reckoning function that impacts how the location of the device is measured. USAA-1028, [0064]. Specifically, in the vehicle mode, a default dead reckoning mode is used that, for example, adjusts weights of acceleration measurements along certain axes. USAA-1028, [0064], [0068]. In the walking mode, a walking mode of dead reckoning mode is used that, for example, considers walking motions, such as pedometer data. *Id.*, [0065], [0071].

102. While Forstall indicates that the type of location estimation using dead reckoning varies based on the operational mode of its device, it lacks implementation details with respect to how the mobile device detects that it is in a vehicle mode absent some explicit user indication. USAA-1028, Abstract, [0064]-[0071]. Forstall also suggests automatic mode shifting is desirable as it teaches enabling button 410 to “automatically switch to walking mode upon step detection” by “detecting walking motions.” *Id.*, [0065]. However, Forstall does not specifically address similar teachings that would have allowed a mobile device to automatically switch to vehicle mode upon detecting that it has been positioned

inside a vehicle. A POSITA reading Forstall would have motivated to seek related practical solutions relating to vehicle mode detection by a mobile device. *Id.*

103. The POSITA would have readily found those solutions within Rabu, and would have been motivated to pursue Rabu's solutions within the systems and processes described by Forstall. Like Forstall, Rabu is focused on mode detection by a mobile device, but further offers several teachings on how mode detection improves the use of a mobile device for monitoring when used in a vehicle. Rabu explains that a mobile device leverages a "generally conventional" accelerometer (such as that found in Forstall's device) to determine an orientation angle and motion status of the mobile device. USAA-1013, 3:1-10, 4:21-33, Figs. 1, 4. It also teaches that sensor data can in turn be leveraged to determine whether the phone is docked within a moving vehicle. USAA-1013, 3:1-10, 4:21-33, Figs. 1, 4. Rabu further explains that mobile device can change a mode of operation based on determining that the device is docked in a moving vehicle (as opposed, for example, to being held by a person). USAA-1013, 8:13-10:42, Figs. 5, 7, 8.

104. A POSITA would have found obvious that a determination that the mobile device is held within a dock located within the vehicle should provide a basis for changing the device's mode of operation to "vehicle mode," which Forstall teaches is used to enable position measurement using a "default dead

reckoning mode.” USAA-1028, [0064], [0070]; USAA-1013, 3:1-10, 4:21-33, Figs. 1, 4.

105. For example, consistent with Forstall’s description of using the “vehicle dead reckoning mode” to adjust weights associated with axial acceleration measurements by accelerometer 172, a POSITA would have found it obvious to leverage motion and orientation data from the same accelerometer to detect whether the device has been positioned inside a vehicle (and should be presently operating in “vehicle mode”). USAA-1028, [0070].

106. The combined disclosures of Forstall and Rabu would have also motivated a POSITA to supplement Forstall’s teachings of detecting a “vehicle mode” on a mobile device based on user input. USAA-1028, [0064]. Forstall teaches a “navigations settings screen 400” through which a user can access a “user selectable touch-sensitive display button 402” to “toggle dead reckoning functions on or off.” *Id.* The POSITA would have found obvious that enabling the device to automatically detect a “vehicle mode” using a docked/undocked status would introduce multiple additional advantages.

107. The Forstall-Rabu combination would have increased user convenience by preventing the need for a user to access a separate navigation settings screen to adjust the mode of the combined device. USAA-1028, [0064]-[0071]; USAA-1013, 1:36-2:14. Rabu’s docking status would have enabled a

determination of when the device is docked within a moving vehicle, which can then be inferred to mean that the device is ready to be used for mobile navigation when the vehicle is being driven. Rabu's docking status would have also improved Forstall's method of enabling a default dead reckoning mode in the vehicle mode. USAA-1028, [0064]. For example, Rabu's docking status would have enabled improved detection of the device being in vehicle mode (during which the default dead reckoning mode is enabled).

108. The Forstall-Rabu combination would have also improved transitioning between the "walking mode" and "driving mode" through use of docking activity as an indicator of when a user has started to drive a vehicle and/or has completing driving. USAA-1028, [0064]-[0071]; USAA-1013, 1:36-2:14. The combination would have enabled docking status to improve the differentiation of "walking mode" and "driving mode" for the device. This type of automated detection is consistent with Forstall's disclosure of an enabling automatic switch between modes. USAA-1028, [0065]. For example, Forstall already contemplates using a footwear impact sensor to detect walking motions and thereby determine when a mobile device is placed in walking mode. A POSITA would have recognized that Forstall thereby contemplates a similar type of detection capability, for example, through use of a docking station status to determine when the device

has been placed in a vehicle and should therefore be placed in driving mode.

USAA-1013, 1:36-2:14.

109. Another advantage provided by the Forstall-Rabu combination is more accurate and/or efficient use of location measurement using dead reckoning. USAA-1028, [0062]-[0072]. The combination would have provided techniques to reduce a likelihood of an incorrect dead reckoning mode being applied when a vehicle is being used for driving. For example, by enabling a dock status to be detected by a mobile device, this removes the need for an implicit prediction of whether the device is presently in a walking mode since its placement on Rabu's dock indicates that the device is not presently being used by the user while walking (and thus, the walking dead reckoning mode is not needed for monitoring).

110. Yet another advantage is the enhanced reliability of motion detection and related determinations of user driving behaviors based on data obtained from sensors within a docked phone relative to an undocked phone. USAA-1028, [0070], [0071]; USAA-1013, 2:61-3:10, 3:46-4:3, 5:61-6:21; USAA-1012, 59:34-43. Recording motion while a phone is docked reduces the possibility of motion artifacts attributable to a user moving the phone while driving. The removal of such motion artifacts would ensure that motion recorded by embedded sensors of the phone are attributable to motion of the vehicle and not to movements unrelated to vehicle motion.

111. Moreover, configuring Forstall's systems to leverage Rabu's teachings would have required only routine programming knowledge, which was well within the skill of a POSITA prior to the earliest effective filing date. Indeed, the change would have amounted to nothing more than the use of a known technique to improve similar devices – in each instance a mobile device with a generic accelerometer – in a similar way, and combining prior art elements according to known methods to yield the predictable results described above.

112. Furthermore, individual elements of the Forstall-Rabu combination would each perform functions they had been known to perform separately from the combination—a mobile device would have adjusted the dead reckoning mode based on a current operational mode (as taught in Forstall), and orientation and motion data from an accelerometer would have been leveraged to determine whether the device is docked inside a vehicle (as taught in Rabu). A POSITA would have naturally expected success when incorporating Rabu's teachings into Forstall's systems since both systems involve using the same type of mobile phone and the same types of sensors to retrieve and process motion data. *Id.*

2. Forstall-Rabu and Langle2009

113. As discussed in Section X.A.1, Forstall describes using a navigation application running on mobile device for vehicle navigation. USAA-1028, [0004], [0030]-[0033], [0042], [0072]. In reviewing this disclosure, a POSITA would have

understood that mobile-based navigation systems (such as the Forstall system) were known to increase the risk of accidents since they typically involve mounting a mobile device to a vehicle dashboard so that a user may view navigation information while driving. For example, Wulff (USAA-1031) recognized that “[a]lthough the placement of [a mobile device] may be convenient in a number of respects, it may also present a potential for accidents[,]” since “a user/driver may be compelled to look at a display of the [mobile device] and thus become distracted.” USAA-1031, [0002]. Curry (USAA-1005) expressed a similar concern, teaching that “[r]esearchers have shown that using mobile phones while driving is four times as likely to get into crashes, and the increased crash risk is similar for hands-free and hand-held phones.” USAA-1005, 1:3-8.

114. Moreover, a POSITA would have perceived safety concerns of mobile device usage in vehicles to be highly relevant to the Forstall system, which contemplates presenting navigation information to a user while a user drives a vehicle. Additionally, this safety risk would have thereby motivated a POSITA looking to implementing Forstall to venture beyond its disclosure to well-known vehicle monitoring systems specifically concerned with safety.” *Id.* Indeed, “varying road and traffic conditions further exacerbates the accidents risks created by mobile navigation systems.” USAA-1032, 323; USAA-1024, [0004]-[0008]).

115. In searching beyond Forstall, a POSITA would have discovered Langle2009—a reference predating Forstall and describing a technique to use data recorded by a mobile device to predict accident-related risks. USAA-1029, 502. Like Forstall, Langle2009’s technique utilizes embedded sensors of mobile phones, including accelerometer data and position data. *Id.* A POSITA would have also been motivated to incorporate Langle2009’s technique into Forstall’s device 100 since Langle2009 teaches “mobile phones may be used to aid in safe driving practices and detection of emergencies.” Indeed, a POSITA would have recognized that sensors used for improving safety in Langle2009 are already present in Forstall’s device 100, and thus, a POSITA would have found it obvious to combine the teachings of the two references.

116. A POSITA would have had a reasonable expectation of success in incorporating Langle2009’s safety techniques into Forstall’s mobile device since Langle2009 recognizes that “[p]rogramming with accelerometers...is straightforward and supports three axes.” *Id.* Further, “it would have been within the capabilities of a POSITA to implement the use of accelerometers for vehicle safety monitoring since such features were conventional by the Critical Date.” As one example, Mohan (USAA-1032) describes using accelerometer data of a mobile device to monitor road and traffic conditions. USAA-1032, 323-24 (“[a] phone might include any or all of a microphone, camera, GPS, and accelerometer, each of

which could be used for traffic sensing functions”). As another example, Wulff (USAA-1031) discloses a mobile device that can be mounted on a vehicle and used for motion detection and vehicle monitoring. USAA-1031, [0014]-[0018].

3. *Forstall-Rabu-Langle2009 and Warren*

117. As previously discussed, Langle2009 describes techniques to improve driver safety by evaluating accelerometer data to identify unsafe driving behaviors. USAA-1030, 502. Langle2009 indicates that “look[ing] at the two horizontal axes [of movement of a mobile device]” can be used to “determine the safety level of **the driver**.” USAA-1029, 502. A POSITA would have understood from and/or found it obvious from this disclosure that unsafe behaviors are driver-specific, and thereby looked to techniques for improving its use to improve driver safety.

118. By the Critical Date, one common and well-known technique of improving driver safety is by numerically representing (“safety metric”) how safe or unsafe certain driving behaviors were based on evaluating recorded motion data (“data on [the] operation of the vehicle”). USAA-1030, Abstract; USAA-1045, [00401]. With this knowledge, a POSITA would have looked to incorporate the use of such techniques into the Forstall-Rabu-Langle2009 combination as this would improve Langle2009’s focus on “classify[ing] driving habits as safe or unsafe.” USAA-1029, 502. A POSITA would certainly see that numerical scores would have enabled the Forstall-Rabu-Langle2009 combination to use thresholds

to differentiate between safe driving activity and unsafe driving activity and simplify the processing needed for effective classification without needed to compare the activity graphs presented in Langle2009. USAA-1030, Figs. 1-5.

119. Warren describes an exemplary technique for “monitoring vehicle operation and using the collected data to calculate a driver score.” USAA-1030, Abstract. The driver score indicates “a risk level associated with insuring a particular driver.” USAA-1030, [0024]. A POSITA would have regarded Warren’s driver score to be reasonably pertinent to Forstall and Langle2009 since all three disclosures are generally focused on improving driver safety through monitoring vehicle motion data. Moreover, incorporating Warren’s driver score into the Forstall-Rabu-Langle2009 combination would have been harmonious—and advanced—Langle2009’s overall motivation to increase the use of mobile devices “as a black box to determine varying levels of risk while riding in a vehicle.” USAA-1029, 502. A POSITA would have also had a reasonable expectation of success in implementing the combination without invention since each reference—Forstall, Langle2009, Warren—contemplates using the same type of data (accelerometer data) to monitoring driving activity. USAA-1028, [0061], [0067]; USAA-1029, 502; USAA-1030, [0020]. In addition, a POSITA would have understood that the types of driving conditions that Warren describes are

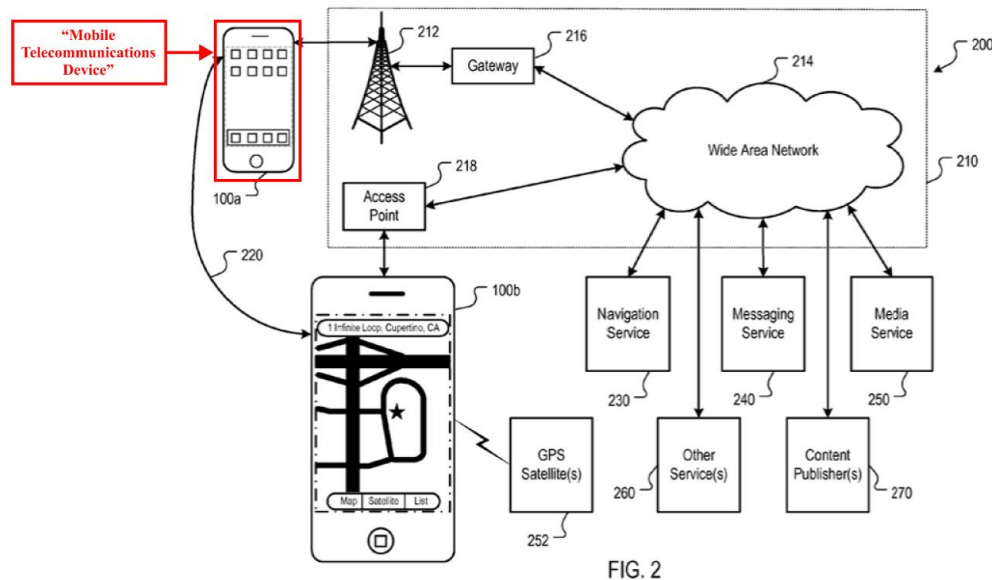
monitored to compute its driving score would have been derived from the sensors in the mobile devices disclosed in Forstall and Langle2009. *Id.*

B. Analysis

1. Claim 1

[1.1] *A mobile telecommunications device configured to log driving information associated with a vehicle:*

120. To the extent the preamble is limiting, the combination discussed in Section XI.A renders it obvious. The combination includes a device 100 (“**mobile telecommunications device**”), which may be “a handheld computer, a personal digital assistant, a cellular telephone, a network appliance, a camera, a smartphone[.]” USAA-1028, [0024], Fig. 1.²



² Unless otherwise indicated, all emphasis has been added in the Petition.

Forstall, Fig. 2 (annotated)

121. Device 100 provides “adaptive mobile device navigation” where “a device position is stored in memory,” “sensor data is received from a motion sensor measuring movement of the device[,]” and “sensor data is compared to map data corresponding to the device location.” USAA-1028, [0006]. Based on these disclosures, a POSITA would have understood to device 100 logs vehicle movement (“*driving activity associated with a vehicle*”). *Id.*, [0065]-[0071].

[1.2] the mobile telecommunications device comprising: a sensor set comprising an image sensor, an audio sensor, an accelerometer or a positioning module, or a combination thereof;

122. As shown below, device 100 includes integrated sensors (“a sensor set”) including accelerometer 172 (“accelerometer”) and compass 173 and/or gyroscope 175 (“positioning module”). USAA-1028, [0061] (“the device 100 includes one or more of an accelerometer 172, a magnetic compass 173, and/or a gyroscope 175[,]” which can be used alone or in combination to “measure movements of the device 100”); [0061].

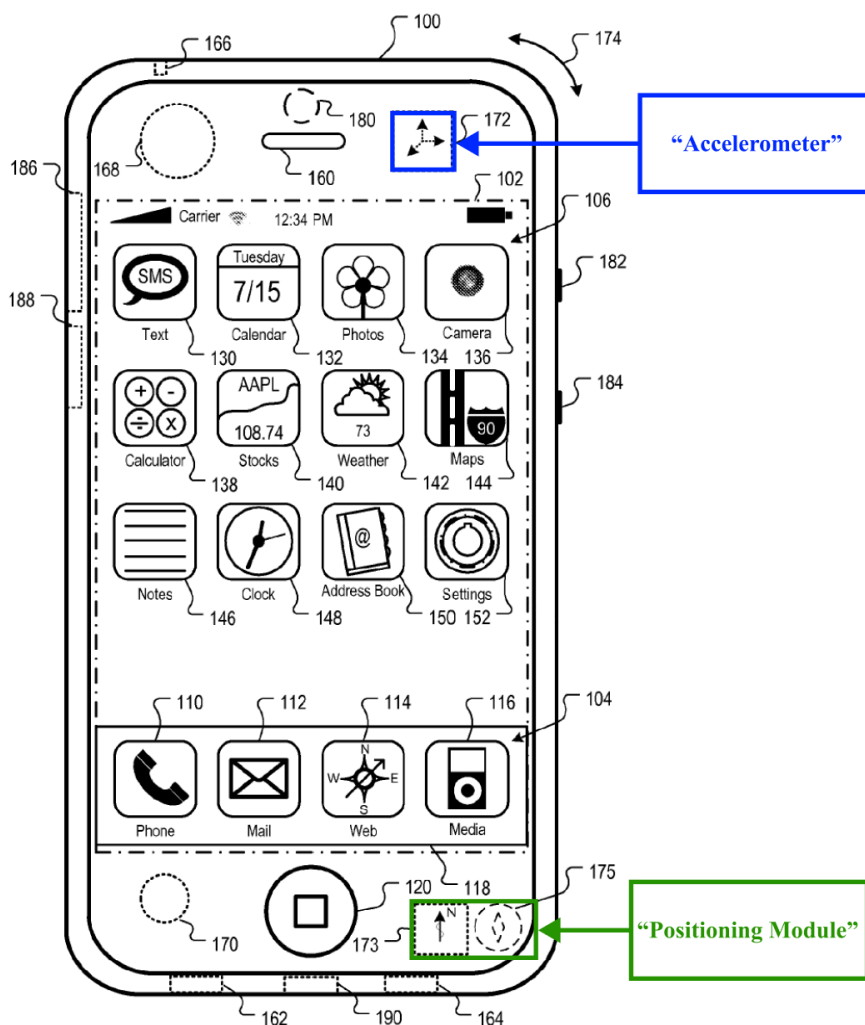


FIG. 1

Forstall, Fig. 1 (annotated)

123. Data from device 100's sensors is used to "measure the movement of the device 100 from a point of origin or a known location" and "determine the device's location" relative to the known location. USAA-1028, [0062]. Forstall also discloses embodiments of device 100 with "an integrated GPS receiver" (*id.*, [0045]) and "circuitry and sensors for supporting a location determining capability such as that provide by [GPS] or other positioning systems..." (*id.*, [0036]). In the

Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have further configured device 100 to process sensor data related to movement of device 100 to identify unsafe driving behaviors (e.g., unsafe acceleration, unsafe braking), which would have been obvious to represent as a numerical score (e.g., driver risk score). See Section XI.A; USAA-1029, 502; USAA-1030, [0020].

[1.3] a user interface;

124. Device 100 runs a navigation application that “display[s] one or more graphical user interfaces on [a] touch-sensitive display 102 for providing the user access to various system objects and for conveying information to the user.”

USAA-1028, [0027]. For example, the navigation application displays map display 500 (“***user interface***”) with “an example path measured by the device 100 from [an] origin 502 to a destination 510...” *Id.*, [0072].

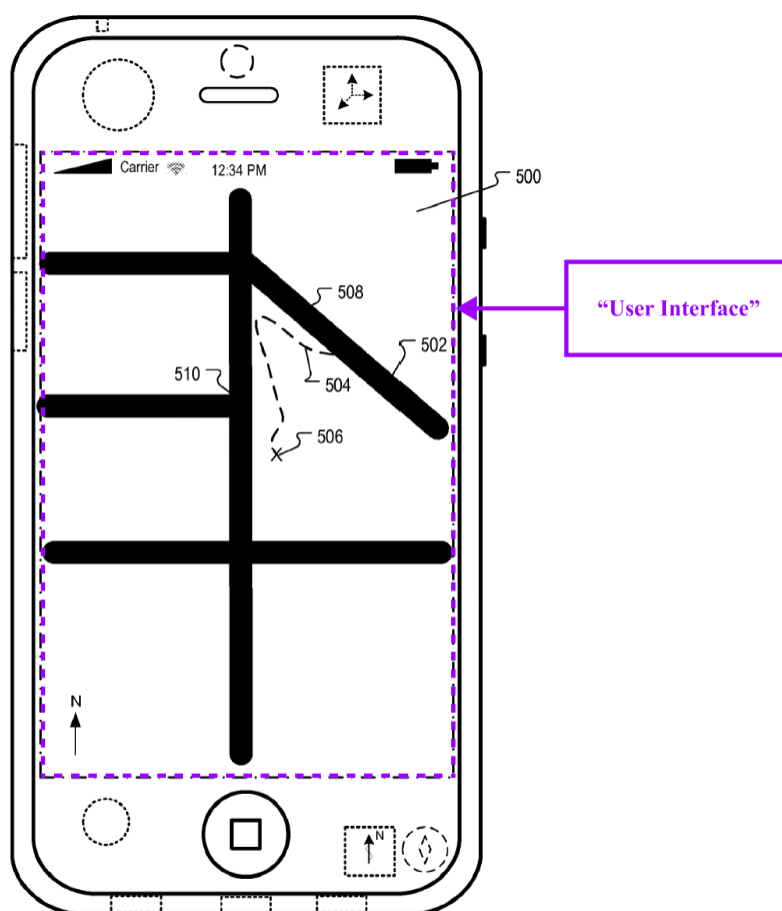


FIG. 5

USAA-1028, Fig. 5 (annotated)

[1.4] a processor; and

125. Device 100 includes “one or more processors” (“**processor**”) for interpreting sensor data “received from one or all of the accelerometer 172, compass 173, and/or gyroscope 175.” USAA-1028, [0074]. The one or more processors “[u]se an on board clock” to “interpret he sensor data as movement of the device 100[,]” and “determine velocity, and position[,]” and/or a direction of travel. *Id.*

[1.5] a memory;

126. Device 100 includes memory (“**memory**”) for storing information relating to “adaptive mobile device navigation,” such as “a device position.” USAA-1028, [0006]. In one exemplary embodiment, device 100 includes “memory 350” that includes “high-speed random access memory and/or non-volatile memory,” e.g., “one or more magnetic disk storage devices, one or more optical storage devices, and/or flash memory (e.g., NAND, NOR).” *Id.*, [0055]. Memory 350 stores “operating system 352,” including “instructions for handling basic system services and for performing hardware dependent tasks.” *Id.*

127. Memory 350 stores various types of instructions providing device functionality, such as “graphic user interface processing,” “sensor-related processing and functions,” “phone-related processes and functions,” “electronic-messaging related processes,” “media processing-related processes,” “navigation-related processes and instructions,” “camera-related processes and functions,” “other processes and functions.” USAA-1028, [0056]. Given such non-limiting disclosures of storing data relating to different types of device functionality, a POSITA would have understood and found obvious to configure memory of device 100 to store raw sensor data (accelerometer data, position data) and data generated from evaluating the raw sensor data (e.g., unsafe driving behaviors).

[1.6] the mobile telecommunications device being configured to: determine, based on at least one of the inputs received by the user interface and sensor data from the device's sensor set, a start of a driving period during which the mobile device is removably attached to the vehicle and the vehicle is in use;

128. This limitation includes a “driving period,” which references a time period “during which [a] mobile device is removably attached to the vehicle and the vehicle is in use.” Though the namesake of the “driving period” suggests driving, because the two claim parameters defining the “driving period” are “removably attached...and...the vehicle is in use,” the claim leaves open the possibility of the driving period corresponding to the beginning, middle or end of, a vehicle’s operation.

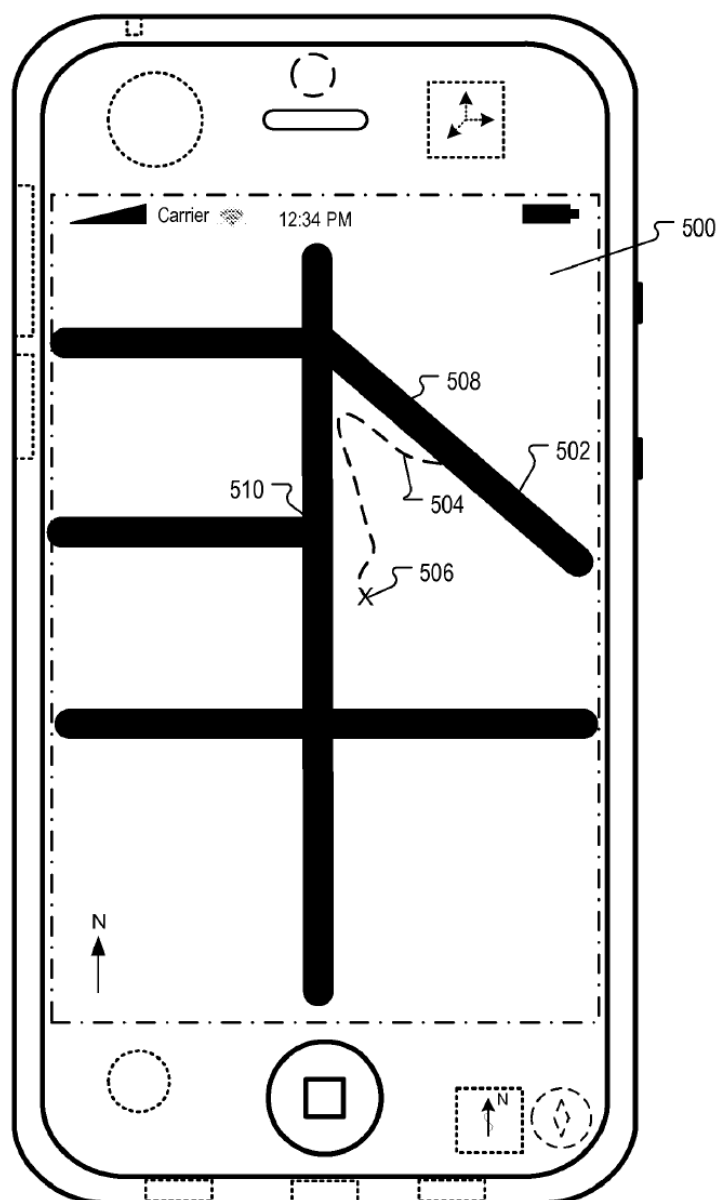
129. The ’879 patent specification is similarly unbounded, as it expressly recognizes several driving period options that are untethered from, e.g., the beginning of the user driving the vehicle. For example, the ’879 patent specification describes that “the mobile device [] register[s] the start of a driving period in response to an initialisation input,” which may be “the user manually executing the application on the mobile device[,]” “the mobile device being installed to the vehicle and/or the vehicle being driven.” USAA-1001, 3:32-62.

130. The claim term establishes just two “driving period” attributes: (1) “the mobile device is removably attached to the vehicle” and (2) “the vehicle is in

use.” *Id.* These two attributes may be satisfied by a start of a monitoring period, whether at the onset of vehicle driving or at some time thereafter.

131. The Forstall-Rabu-Langle2009-Warren describes runs a navigation application to “provide directions from a point of origin to a destination” and “display[] a current position on a map as well as deliver navigation instructions based on the current position to route a user to a desired destination.” USAA-1028, [0004]. As discussed below, Forstall-Rabu-Langle2009-Warren device meets each of the requirements imposed by [1.6] of the configuration of a “mobile telecommunications device” to determine a “start of a driving period” identified in Section XI.B.1.

132. Fig. 5 shows map display 500 (“***user interface***”) provided by the navigation application while it is being used for real-time navigation, i.e., navigation period (“***driving period***”).



USAA-1028, Fig. 5

133. A POSITA would have understood that the start of a navigation period (“*start of a driving period*”) is determined based on a user’s interaction with map display 500 (“*inputs received by the user interface*”), for example, when a user specifies a “desired destination” (destination 506) for the map display 500 to

“provide directions from a point of origin to [the] destination[.]” USAA-1028, [0004], [0072]. A user also interacts with objects displayed on a top-level interface graphical of device 100 to access the user interfaces specifically provided by the navigation application (e.g., map display 500). For example, Figure 1 (below) shows the user “invok[ing] a map functionality, e.g., by pressing the maps object 144 on the top-level graphical user interface...and has requested and received a map for the location ‘1 Infinite Loop, Cupertino, Calif.’” USAA-1028, [0042].

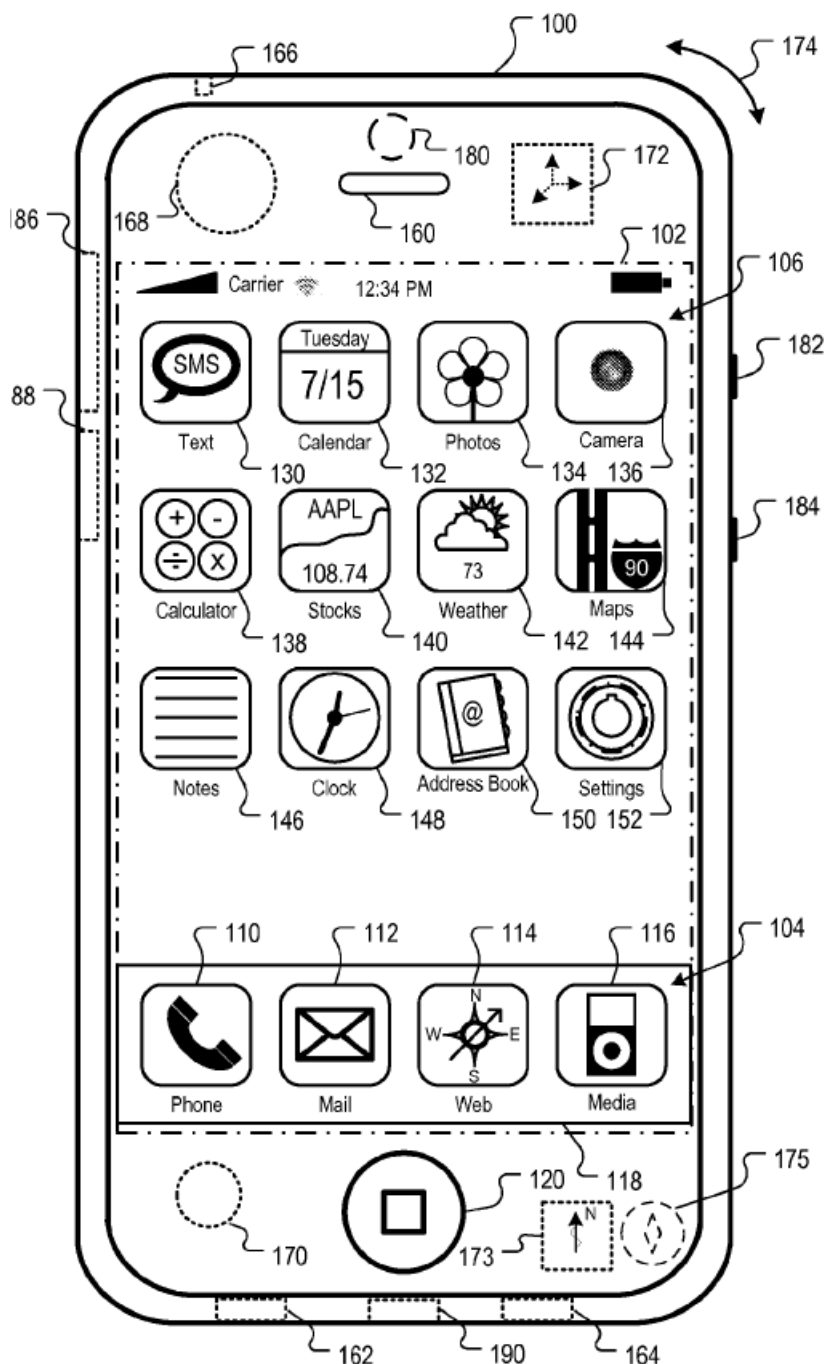
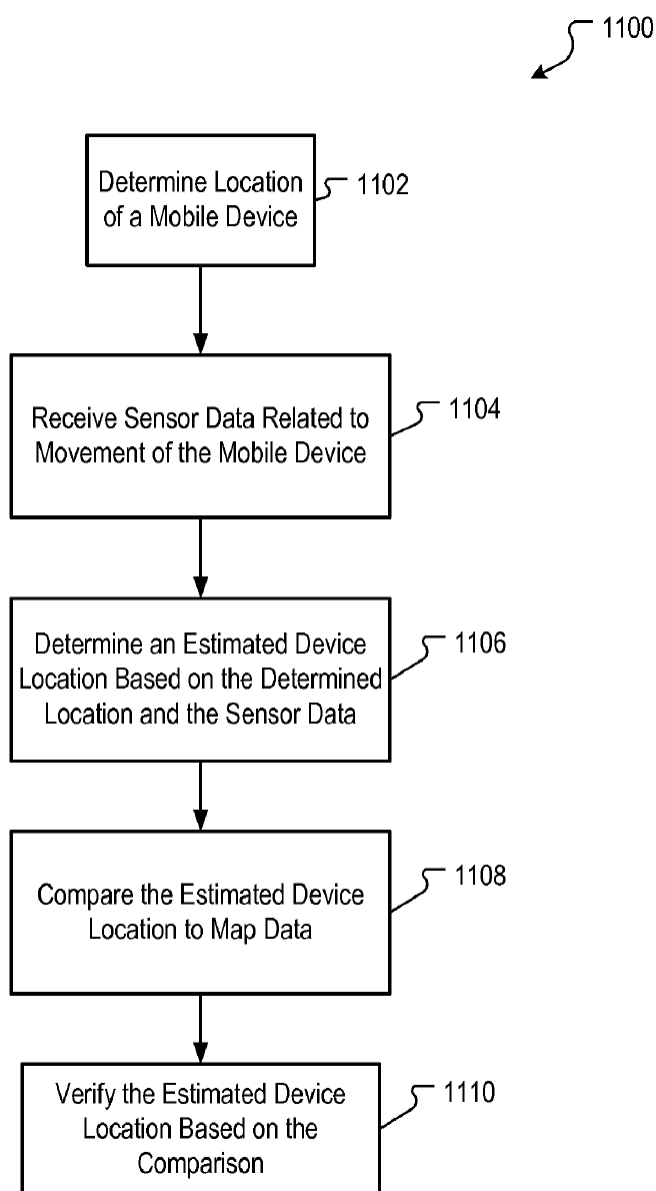


FIG. 1

USAA-1028, Fig. 1

134. A POSITA would have also understood that the start of a navigation period (“*start of a driving period*”) is determined based on data collected by

integrated sensors (“*sensor data from the device’s sensor set*”), for example, when device 100 determines an estimated device location to set for the “point of origin” (origin 502). USAA-1028, [0072], [0082]. In a process shown in Figure 11 (below), the estimated device location is determined based on sensor data received from “accelerometer 172, compass 173, gyroscope 175,” and by, for example, “performing dead reckoning calculations using the received sensor data to measure movements of the mobile device from the determined location.” *Id.*, [0073], [0082].



USAA-1028, Fig. 11

135. Based on the disclosures discussed above, in the example shown in Fig. 5, a POSITA would have understood that the start of the navigation period (“*start of a driving period*”) is based on the user’s interaction with map display 500 (“*inputs received by the user interface*”) and sensor data used to estimate

device location in identifying an origin to be used for route guidance (“***sensor data from the device’s sensor set***”). USAA-1028, [0004], [0042], [0072], [0073], [0082], [0083].

136. Moreover, a POSITA would have combined Forstall and Rabu by configuring device 100 to be “mounted in a vehicle” using an “automobile dock” or “vehicle holder,” and thus, be “***removably attached to the vehicle***” prior to and/or during a navigation period where a vehicle is traveling along a navigation path from an origin to a destination (“***the vehicle is in use***”). USAA-1013, 3:11-45, Figs. 1, 2. As discussed in Section XI.A, a POSITA would have been motivated to implement this configuration since it would have improved the transitioning of modes of operation (walking mode, vehicle mode) on device 100 using a “dock status” indicating attachment to “automobile dock” or “vehicle holder” (as taught in Rabu). The detection of a “dock status” enables device 100 to confirm that it has been positioned inside a vehicle and thereby should automatically transition to “vehicle mode” so that “a vehicle dead reckoning mode” is appropriate to process accelerometer data to “determine how the device is positioned relative to the earth’s gravity.” USAA-1028, [0071]; *see id.*, [0064], [0065], [0068], [0070]; USAA-1013, 3:1-10, 4:21-33, 8:13-10:42, Figs. 1, 4, 5, 7, 8.

[1.7] process the sensor data from the sensor set during the driving period to derive driving information associated with how the vehicle is driven; and

137. As discussed for [1.2], in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to collect sensor data related to movement of device 100 from its integrated sensors (“**sensor data from the sensor set**”) while a navigation application is running on device 100 and used for monitor vehicle movement (“**during the driving period**”). USAA-1028, [0036], [0045], [0061]. Langle2009 describes evaluating (“**processing**”) sensor data (e.g., accelerometer measurements) to identify driving safety data indicating safe and unsafe driving behaviors (“**driving information associated with how the vehicle is driven**”). USAA-1029, 502 (“Using accelerometer measurements, it should be possible to classify driving habits as safe or unsafe”). Examples of unsafe driving behaviors include unsafe acceleration/deceleration and safe/unsafe braking, both of which relate to how a monitored vehicle is being driven. *Id.* (“the driver has direct control over them in the way he steers, accelerates and/or breaks[]”), 503-504, Figs. 2, 4.

[1.8] store a selection of the driving information to the memory;³

138. As discussed for [1.2], in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would configured memory of device 100 (e.g., memory 350) to store driving safety data (“**store a selection of the driving information to the memory**”). USAA-1028, [0056]. Forstall provides non-limiting disclosure of storing data relating to different types of device functionality, including “sensor-related processing and functions,” which would led a POSITA to recognize memory 350 as being a suitable storage medium for storing driving safety data. USAA-1028, [0055], [0056]. Such a configuration advances Langle2009’s motivation to use a smartphone as “a black box to determine varying levels of risk while riding in a vehicle.” USAA-1029, 507. Additionally, a POSITA would have recognized that storing driving safety data in smartphone memory was a well-known technique by the Critical Date. USAA-1042, Abstract. A POSITA would have recognized that storing driving safety data in smartphone memory was a well-known technique by the Critical Date. For example, Callopy shows “the automobile insurance industry” goal to “collect and

³ This claim limitation describes a “selection” of “driving information” but there is no indication in this or other claim limitations that the selection is performed by the “mobile telecommunications device.”

integrate information as black boxes (e.g., that operate either outside the user's visual awareness or that provide feedback through web pages or GPS (global positioning system receiver displays).” USAA-1045, [00302], [00315-00316]. The Callopy “mobile device 4005” can be “temporarily stored in the [memory] buffer 4170” until communications are established with the insurance company. USAA-1045 [00034], [00329]. Further, Callopy describes the processing of raw data by “the mobile device 4005 [which] can include one or more local applications 4180” and to “prevent data overflow of the [memory] buffer 4170, the local applications 4180 can process the data as it is gathered thereby allowing the processed data to be stored as oppose to the raw data, where it is envisioned that the processed data occupies less memory than the raw data.” USAA-1045, [00330].

139. If the limitation is interpreted to require a selection of a subset for storage, the Forstall-Rabu-Langle2009-Warren device renders this interpretation obvious. A POSITA would have found obvious to store in the Forstall-Rabu-Langle2009-Warren device a subset of (i.e., selection of) the recorded sensor data since Forstall explains storage of various types of data, indicating that specific types of recorded data are more useful for storage than others. USAA-1028, [0055], [0056]; USAA-1015, 233-250.

[1.9] wherein the driving information is derived without data from the vehicle sensors, and

140. As discussed for [1.7], driving safety data (“**driving information**”) is determined based on evaluating sensor data collected by integrated sensors of device 100 (accelerometer 172, compass 173, gyroscope 175). USAA-1028, [0036], [0045], [0061]. A POSITA would have understood that the driving safety data is derived “**without data from vehicle sensors**” since Forstall and Langle2009 each teach data collection and processing techniques using data from smartphone sensors. *Id.*, [0006], [0007], [0061]; USAA-1029, 502-503; USAA-1031, [0010].

[1.10] the mobile telecommunications device is controlled by a downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.

141. Forstall describes examples of display objects used to access applications on device 100 and further describes that device 100 “may download additional applications or other software that provides other functions and corresponding display objects.” USAA-1028, [0033]. Based on this, a POSITA would have understood that the navigation application is downloaded by device 100, and thus, a “**downloaded application.**” USAA-1028, [0042], Fig. 5. As discussed in Section XI.A, the navigation application monitors location information on device 100 such that device 100 is “**controlled**” by the navigation application while a user accesses map data. *Id.*, [0030]-[0033], [0042].

142. Further, as discussed in Section XI.A, a POSITA would have configured device 100 to determine a driver score based on the driving safety data (“***driver score associated with a particular driver***”). USAA-1029; USAA-1030. As described in Warren, the driver score reflects “a qualitative view of the driving characteristics for a particular vehicle or a combination of a vehicle and driver[.]” such as “a risk level associated with insuring a particular driver[.]” USAA-1029, [0024]. The driver score can be based on “speeds at which the vehicle is operated.” *Id.*, [0014]. A POSITA would have understood that Langle2009’s driving safety data relates to risks associated with driving, and thus, found it obvious to configure device 100 to compute the driver score based on processing information represented by the driving safety data (e.g., unsafe acceleration, unsafe braking) (“***process the driving information to generate a driving score associated with a particular driver***”). USAA-1029, 502-503; USAA-1030, [0014], [0024]. For example, Warren teaches embodiments where the driver score “include[s] a variety of parameters with various weights applied to the parameters[.]” and a POSITA would have found it obvious that to determine parameter weights based on identifying unsafe driving behaviors from sensor data (as taught in Langle2009). USAA-1030, [0051].

2. *Claims 21, 46, 51, 54*

143. The Forstall-Rabu-Langle2009-Warren-Langle2009 combination renders these claims obvious in the same manner as explained above for the corresponding claim 1 limitations listed in the table below.

Claim 1 Limitation	Corresponding Limitations
[1.1] ⁴	[21.1], [46.1], [51.1], [54.1]
[1.2]	[21.2], [46.2], [51.3], [54.2]
[1.3]	[21.2], [21.4], [46.3], [54.3]
[1.4]	[21.3], [21.4], [46.4], [51.4], [54.4]
[1.5]	[21.4], [46.5], [51.5], [54.5]
[1.6] ⁵	[21.6], [46.6], [51.6], [54.6]
[1.7]	[21.7], [46.7], [51.7], [54.7]
[1.8]	[21.8], [46.8], [51.8], [54.8]
[1.9]	[21.10], [46.9], [51.10], [54.9]

⁴ Preambles [1.1] and [54.1] describe a “mobile telecommunications device,” while preambles [21.1] and [51.1] describe a “non-transitory computer readable medium.” While none of the preambles are limiting, the Curry-Rabu combination renders them obvious, as discussed in Sections XI.B.1 ([1.1], [54.1]) and XI.B.2 ([21.1], [51.1]).

⁵ Limitation [54.6] differs from limitation [1.6] by a single word (“affixed” in [54.6] compared to “attached” in [1.6]). The ’879 patent specification does not distinguish the two terms “affix” versus “attach.”

Claim 1 Limitation	Corresponding Limitations
[1.10]	[21.9], [46.12], [51.9], [54.10]

[21.1], [51.1] A non-transitory computer readable medium having instructions comprising a software application stored thereon, wherein the instructions are configured to be executed on a processor of a mobile telecommunications device to enable the mobile telecommunications device to log driving information associated with a driver of a vehicle,

144. As discussed for [1.5], the Forstall-Rabu-Langle2009-Warren device includes memory that stores, for example, “operating system 352,” including “instructions for handling basic system services and for performing hardware dependent tasks.” USAA-1028, [0006]. Forstall also describes that the memory stores various types of instructions providing device functionality, thereby rendering obvious that the memory is a “***non-transitory computer readable medium having instructions comprising a software application stored thereon.***” USAA-1028, [0056].

[21.2a], [51.2a] the mobile telecommunications device including a display;

145. Device 100 includes “touch-sensitive display 102” (“***display***”) that can be implemented using “liquid crystal display (LCD) technology” or light emitting polymer display (LPD) technology” and is “sensitive to haptic and/or tactile contact with a user.” USAA-1028, [0025]-[0027].

[21.2b], [51.2b] present a user interface on the display;

146. As discussed for [1.3] and [21.2a], the Forstall-Rabu-Langle2009-Warren device “display[s] one or more graphical user interfaces on [a] touch-sensitive display 102 for providing the user access to various system objects and for conveying information to the user.” USAA-1028, [0027]. A POSITA would have understood and found it obvious that the display “***present[s]***” the one or more graphical interfaces on display 102. *Id.*, [0025]-[0027].

[46.10] the mobile telecommunications device is configured to process the sensor data by determination of at least one of: vehicle acceleration events; and vehicle braking events;

147. As previously discussed (Section XI.A, and for [1.2], [1.7]), device 100 processes accelerometer readings (“***sensor data***”) using “vehicle dead reckoning” to detect vehicle accelerations in a positive axial direction (“***vehicle acceleration events***”) and vehicle accelerations in a negative axial direction (“***vehicle braking events***”). USAA-1028, [0062], [0063], [0070], [0081], [0082]. Specifically, when in “vehicle mode,” device 100 applies a “vehicle dead reckoning mode [that] uses an accelerometer reading to determine how the device is positioned relative to gravity.” USAA-1028, [0070]. Further, “[a]ccelerations along the axes perpendicular to the detected gravity axis” are used to identify “accelerations that contribute to displacement of the vehicle from a known fix to a second position to be measured via dead reckoning and displayed on a map.” *Id.*

148. Moreover, the combination discussed in Section XI.A renders this limitation obvious since Langle2009 teaches processing accelerometer measurements (“**sensor data**”) to detect driving safety data, including unsafe acceleration (“**vehicle acceleration events**”) and unsafe braking (“**vehicle braking events**”). USAA-1029, 502-504, Figs. 2, 3. Specifically, “a change in the vehicle’s speed is measured along the x axis[,]” where “acceleration” is “an increase in speed” and “deceleration” is “a decrease in speed.” *Id.*, 502-503.

[46.11], [51.11] wherein the determining of such events occurs when data from the sensor set accords with predefined threshold values; and

149. As discussed for [1.7], Langle2009 describes evaluating accelerometer measurements) to identify safe and unsafe driving behaviors. USAA-1029, 502. A POSITA would have understood that this identification is based on classifying detected driving behaviors (e.g., acceleration, braking) as “safe” and “unsafe” driving behaviors and found obvious that an example of classification technique is using measured acceleration values (“**predefined threshold values**”) to differentiate the two types of driving behaviors. For example, as shown in Fig. 1 (below), “safe acceleration and deceleration never reaches more than 0.3 g in either the positive or negative direction.” USAA-1029, 503.

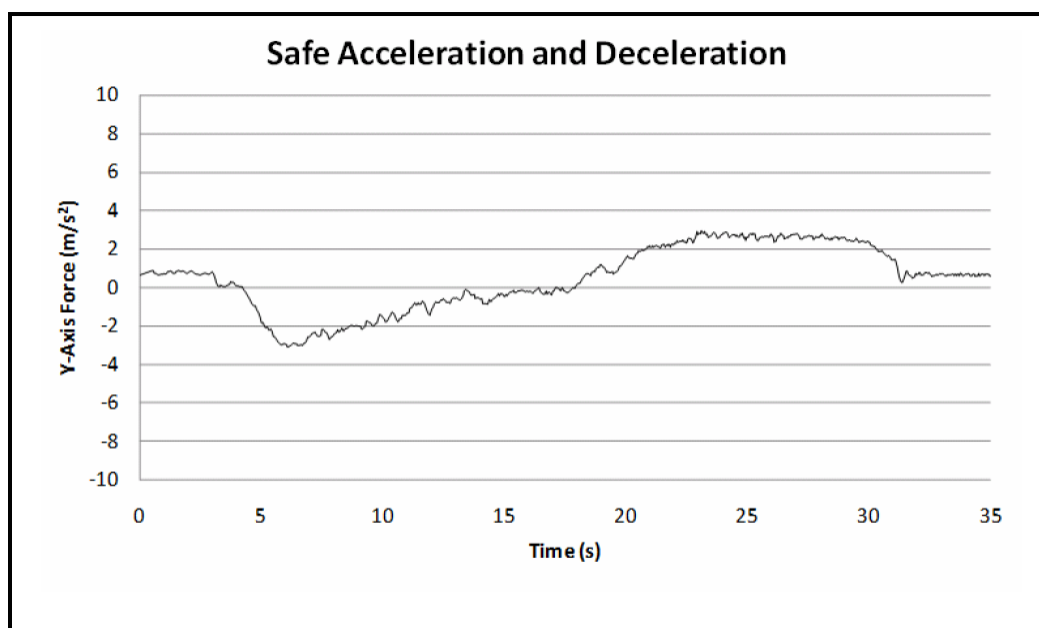


Figure 1. Safe Acceleration and Deceleration

USAA-1029, Fig. 1

150. In contrast, in Fig. 2 (below), the acceleration measurements have “the same overall shape” but have “a slightly higher G-force of 0.43 g on this incline.” *Id.* From these examples, unsafe acceleration is determined when measured acceleration exceeds a threshold value of 0.3 g. As another example, in Fig. 5 (below), acceleration measurements have “a G-force of well over 0.5 g in the x direction[,]” which indicates an unsafe lane change. USAA-1029, 504. In this example, the unsafe lane change is determined when measured acceleration in the x direction exceeds a threshold parameter value of 0.5 g.

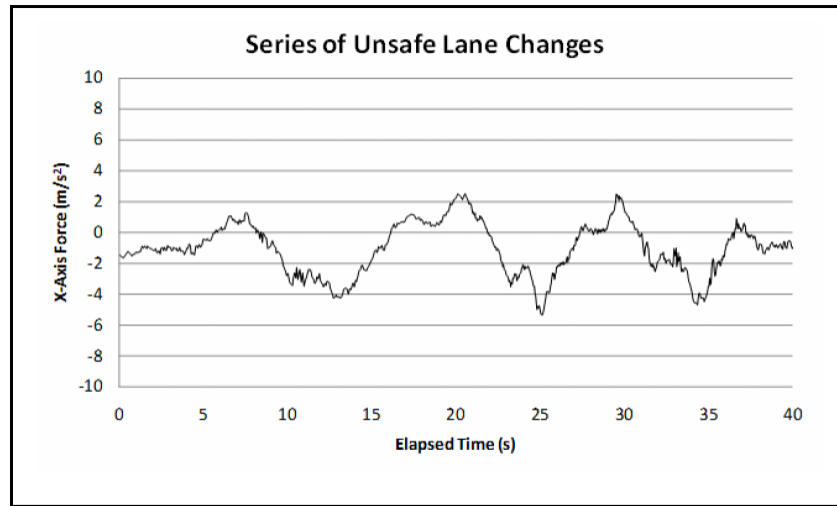


Figure 5. A Series of Unsafe Lane Changes

USAA-1029, Fig. 5

3. Claims 2, 3, 5, 8, 11-13, 19, 20, 41, 42

[2] ***A mobile telecommunications device according to claim 1, wherein the mobile telecommunications device is controlled by the downloaded application to control the mobile device to detect occurrence of a predetermined event and in response take at least one predetermined action.***

151. As discussed for [1.7] and [1.10], in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to classify driving behaviors based on sensor data, such as unsafe acceleration and unsafe breaking. USAA-1029, 502. A POSITA would have understood detection of a driving behavior to represent “***detect occurrence of a predetermined event***” since the detected behaviors are among a finite number of predetermined classifications. *Id.* Further, because Warren describes using weights to compute parameters for a driver score, a POSITA would have found it obvious that in at

least some configurations of the combination, detection of an unsafe driving behaviors results in adjusting a weight in computing the driver score (“**take at least one predetermined action**”). USAA-1030, [0051].

[3] A mobile telecommunication device according to claim 2, wherein predetermined action is storing driving information associated with that event to the memory.

152. As discussed for [1.5] and [1.8], in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to store driving safety data (e.g., unsafe acceleration, unsafe braking) in memory (“**storing driving information...to the memory**”). USAA-1028, [0055], [0056]; USAA-1029, 507. Because stored driving safety data is evaluated to identify an unsafe acceleration (detect occurrence of an “**event**”), the stored driving safety data is **associated with that event**.”

[5] A mobile telecommunication device according to claim 2, wherein predetermined action is transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system.

153. Warren discloses a central system 170 (“**remote system**”) that receives data collected and/or generated for a monitored vehicle. USAA-1030, [0021]. Warren describes monitored data to central system 170 for processing (“transmitting driving information...to a remote system”). A vehicle monitor “periodically transmit[s] collected data to the central system 170[,]” using “wireless technology,” such as “FLEX, REFLEX, POCSAG, AMPS, NAMPS,

TDMA, CDMA, GSM, GPRS...” *Id.*, [0022]. Forstall describes that device 100 includes “one or more wireless communication subsystems” (“**wireless telecommunications module**”), including “802.11b/g communication device 186, and/or a Bluetooth™ communication device 188.” USAA-1028, [0038]. Thus, in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to provide driving safety data to central system 170 using one or more wireless communication subsystems (“**transmitting driving information via a wireless telecommunication module of the mobile telecommunication device**”).

[8.1] A mobile telecommunications device according to claim 2, wherein the predetermined action comprises communicating to a remote system that an event has been detected,

154. As discussed for [2] and [5], in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to detect an unsafe acceleration from driving safety data (detect an “**event**”) and provided the driving safety data to central system 170 (“**communicating to a remote system that an event has been detected**”). USAA-1029, 502; USAA-1030, [0022], [0038], [0051].

[8.2] the mobile telecommunications device being further configured to receive from the remote system a request to transmit to the remote system selected portions of the driving information associated with the detected event.

155. In the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to receive a request from Warren's central system 170 to transmit driving safety data (***“request to transmit to the remote system selected portions of the driving information associated with the detected event”***). USAA-1030, [0022], [0023]. Further, “the communication protocol between a mobile device and an associated server was an obvious design choice by the Critical Date because systems that enabled various types of communication between devices were well-known by the Critical Date.” Zhao (USAA-1041) is an example of a telematics system in which a mobile device used for monitored receives a request from an associated server for monitoring data collected by the mobile device. USAA-1041, 11. As another example, Callopy describes a telematics system in which a mobile device used for monitored receives a request from an associated server (***“aggregation component 4048”*** within ***“insurance provider system 4035”***) for monitoring data collected by the mobile device (***“mobile device 4005”***). USAA-1045, [00307]-[00308], FIG. 40, FIG. 41.

[11] A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to manage voice-calls

incoming to the mobile telecommunications device during a driving period.

156. Device 100 can be “cellular telephone” or a “smartphone” and “can place and receive phone calls (e.g., using VoIP protocols)[.]” USAA-1028, [0024], [0040]. Based on these disclosures, a POSITA would have recognized certain scenarios where device 100 receives an incoming phone call while the mobile navigation application (“***downloaded application***”) is used for navigation (“***driving period***”). USAA-1028, [0024], [0040]. For such instances, a POSITA would have looked to disclosure that memory of phone 100 includes “graphical user interface instruction 356 to facilitate graphic user interface processing” and “phone instructions 360 to facilitate phone-related processes and functions[.]” USAA-1028, [0056]. From these disclosures, a POSITA would have configured the navigation application to display information relating to the incoming phone call and thereby “***manage voice-calls incoming to the mobile telecommunications device during a driving period.***” *Id.*

[12] A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to enable a hands-free mode of operation on detection of the driving period.

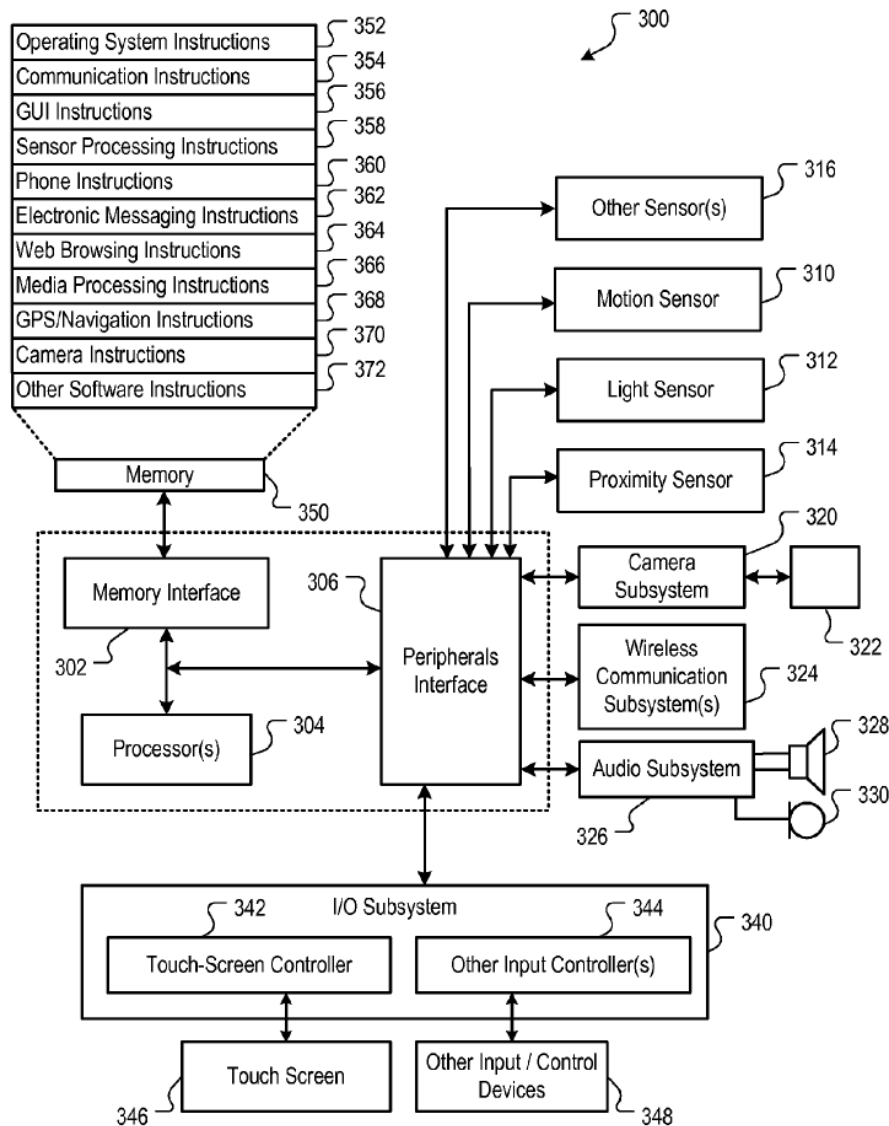
157. Device 100 can include “a loudspeaker 164” to “facilitate hands-free voice functionalities, such as speaker phone functions.” USAA-1028, [0034]. A POSITA would have found it obvious to configure device 100 to enable hands-free voice functionality while the navigation application is being used for navigation

(“**driving period**”) since a user is occupied driving a vehicle and is unable to fully interact with device 100. One obvious configuration is that the navigation application controls device 100 to enable hands-free functionality upon detecting a start of navigation (“**enable a hands-free mode of operation on detection of the driving period**”) since the use of hand-free functions to increase user safety while using mobile navigation systems were well-known by the Critical Date. *Id.* For example, U.S. Pat. No. 5,274,560 (LaRue) disclosed an audio navigation system in which a user can provide voice input to enable a non-distracting and safe way to use navigation features while a vehicle is in motion. USAA-1033, Abstract. LaRue also cites several patents that “pertain to voice actuated control of a vehicle and are representative of these existing navigation systems,” further confirming the conventionality of the feature recited by this claim. USAA-1033, 1:45-50.

[13] A mobile telecommunications device according to claim 12, wherein the hands-free mode of operation comprises enabling voice-activated commands on the mobile device.

158. As discussed for [12], device 100 “facilitate[s] hands-free voice functionalities, such as speaker phone functions.” USAA-1028, [0034]. In an exemplary implementation (shown in Fig. 3 below), device 100 includes “audio subsystem 326,” “speaker 328,” and “microphone 330[,]” which collectively “facilitate voice-enabled functions, such as voice recognition, voice replication, digital recording, and telephony functions.” *Id.*, [0050]. Because device 100

provides voice recognition capabilities, device 100 “***enable[s] voice-activated commands***” through microphone 300.



USAA-1028, Fig. 3

[19] A mobile telecommunications device according to claim 1, wherein the mobile telecommunications device utilizes its own power supply.

159. Device 100 can be “cellular telephone” or a “smartphone” and “can place and receive phone calls (e.g., using VoIP protocols)[.]” USAA-1028, [0024],

[0040]. A POSITA would have understood and found obvious that device 100 includes a battery as a power source (“**utilizes its own power supply**”) since cellphones and smartphones were known by the Critical Date to include batteries. USAA-1039, 2; USAA-1040, 32-34.

[20] A mobile telecommunications device according to claim 1, wherein the mobile telecommunications device is a smartphone.

160. As discussed for [1.1], device 100 can be a “smartphone” and “can place and receive phone calls (e.g., using VoIP protocols)[.]” USAA-1028, [0024], [0040].

[41] A non-transitory computer readable medium according to claim 21, wherein the processing step comprises determination of at least one of: vehicle acceleration events and vehicle braking events.

161. As discussed for [1.7], device 100 uses “[s]ensor data from accelerometers, a compass, gyroscopes, and impact sensors” to “measure the movement of the device 100...” USAA-1028, [0062]. Device 100 also “detects an axis of periodic sudden accelerations using the accelerometer 172...” *Id.*, [0071]. Further, “[i]n the vehicle mode, sudden accelerations in a positive or negative direction” are also measured along several axes using accelerometer 172. A POSITA would have therefore configured device 100 to detect both sudden accelerations in the positive direction (“**vehicle acceleration events**”) and sudden accelerations in the negative direction (“**vehicle braking events**”). A POSITA would have also configured device 100 to detect driving safety data from

accelerometer measurements, including both safe/unsafe accelerations (“**vehicle acceleration events**”) and safe/unsafe braking (“**vehicle braking events**”). *Id.*; USAA-1029, 502-504.

[42] A non-transitory computer readable medium according to claim 41, wherein processing step comprises determination of vehicle swerving events and

162. As previously discussed, Forstall and Langle2009 each describe identifying a direction of travel by a vehicle using sensor data collected by a mobile device (e.g., accelerometer data, GPS data). USAA-1028, [0070], [0071], [0075], [0076]; USAA-1029, 502. Forstall describes that the sensor data can be processed to “determine a change of direction[]” (USAA-1028, [0070]), and similarly, Langle2009 describes using triaxial acceleration measurements to identify a “[c]hange in direction ([s]teering)” (USAA-1029, Table 1). According to Langle2009, “[u]sing this data, not only is it possible to count lane changes and detect when they occur, it is possible to classify safe and unsafe lane changes.” USAA-1029, 502. Thus, in the Forstall-Rabu-Langle2009-Warren combination (see Section XI.A), a POSITA would have configured device 100 to determine unsafe lane changes (“**determination of vehicle swerving events**”) from sensor data collected by integrated sensors.

163. Additionally, Langle2009 describes evaluating sensor data (e.g., accelerometer measurements) to identify driving safety data indicating safe and

unsafe driving behaviors. USAA-1029, 502. A POSITA would have found obvious that the classification of driving behaviors involves the use of “*preset parameters*” to differentiate between “safe” and “unsafe” driving behaviors. For example, as shown in Fig. 1 (below), “safe acceleration and deceleration never reaches more than 0.3 g in either the positive or negative direction.” USAA-1029, 503.

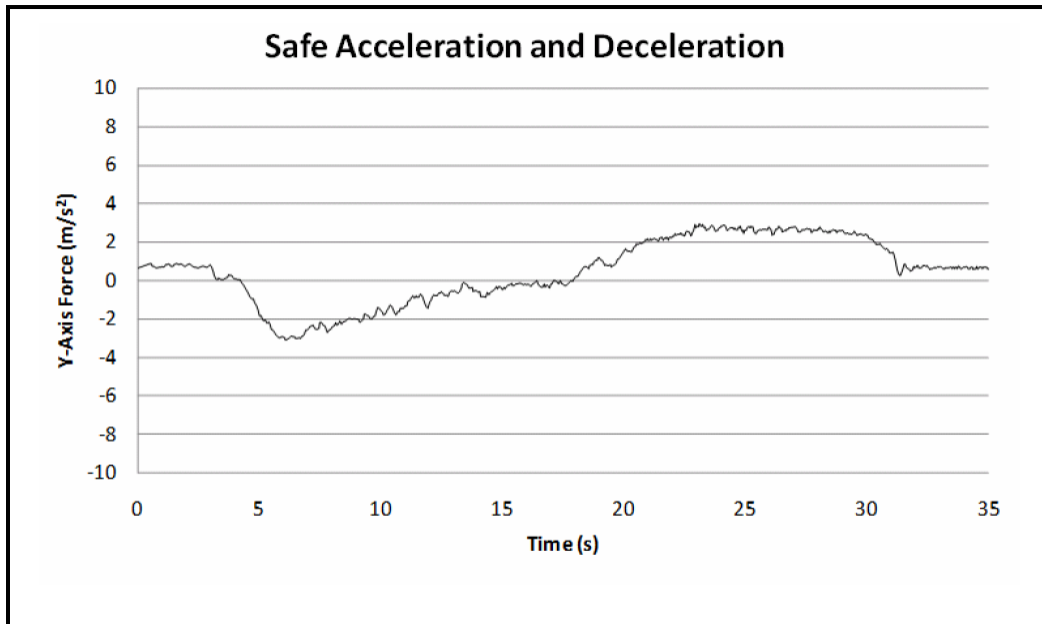


Figure 1. Safe Acceleration and Deceleration

USAA-1029, Fig. 1

164. In contrast, in Fig. 2 (below), the acceleration measurements have “the same overall shape” but have “a slightly higher G-force of 0.43 g on this incline.” Id. From these examples, unsafe acceleration is determined (“determination of such events occurs”) when measured acceleration exceeds a threshold parameter value of 0.3 g (“when data from the sensor set accords with

preset parameters”). As another example, in Fig. 5 (below), acceleration measurements have “a G-force of well over 0.5 g in the x direction[,]” which indicates an unsafe lane change. USAA-1029, 504. In this example, the unsafe lane change is determined (“determination of such events occurs”) when measured acceleration in the x direction exceeds a threshold parameter value of 0.5 g (“when data from the sensor set accords with preset parameters”).

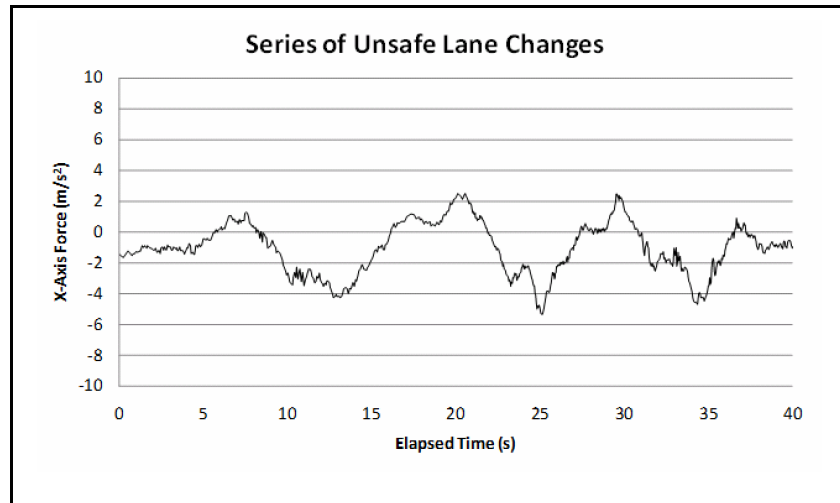


Figure 5. A Series of Unsafe Lane Changes

USAA-1029, Fig. 5

4. *Additional Claims*

165. The Forstall-Rabu-Langle2009-Warren combination (see Section XI.A) renders these claims obvious in the same manner as explained above for the corresponding claims listed in the table below.

Claim Limitation	Corresponding Limitations
[2]	[22]
[3]	[23]
[5]	[25]
[8.1]-[8.2]	[28.1]-[28.2]
[11]	[29]
[12]	[30]
[13]	[31]
[19]	[39]
[20]	[40]
[42]	[44], [47], [49], [52]
[41] ⁶	[43], [48]

XII. [GROUND 1B] – FORSTALL, RABU, LANGLE2009, WARREN, AND TAMIR RENDERS CLAIMS 4 AND 24 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren-Tamir Combination

166. As discussed in the previous section, Tamir discloses an exemplary data collection technique where a sampling rate is adjusted based on conditions associated with data collection (e.g., location of driving, driving behavior). USAA-1006, 9:10-20, 20:52-21:11. A POSITA would have recognized that incorporating

⁶ Claims 43 and 48 require determinations of “both” of “vehicle acceleration events” and “vehicle braking events,” while claim 41 requires determinations of “at least one of” these features. As explained for [41], the Curry-Rabu combination renders the narrower requirements of claims 43 and 48 obvious.

Tamir's data collection technique into the Forstall-Rabu-Langle2009-Warren combination would have improved motion recording by, for example, allowing "lower power consumption and less wear and tear of" phone 100. USAA-1006, 20:52-21:2. Moreover, "dynamic sampling rates were conventional by the Critical Date and known to provide several advantages to data processing in vehicle monitoring systems, such as maintaining measurement precision, high adaptation to different driving conditions, and increased responsiveness." USAA-1017, 5:61-6:9, 9:3-7; USAA-1018, [0019]; USAA-1019, 5:1-3.

B. Analysis

1. Claims 4, 24

[4], [24] A mobile telecommunication device according to claim 2, wherein predetermined action is storing driving information captured at a higher sampling rate than when an event is not detected.

167. As discussed in Section XII.A, a POSITA would have configured device 100 to use Tamir's data collection technique to use variable sampling rates and improve Forstall's data recording technique. USAA-1006, 9:10-20, 20:52-21:11. Tamir describes that "the sampling rate is adjusted according to the driving pattern of vehicle 15" and that "when it is determined that the driver is driving relatively daringly, a higher sampling rate is used." *Id.*, 20:52-21:2. Tamir also contemplates adjusting data collection "at special occasions, such as when an accident is possible." *Id.* A POSITA would have therefore found it obvious to

configure device 100 to detect an unsafe driving behavior (“***and event***”) using a higher sampling rate for data collection relative to other scenarios (“***driving information captured at a higher sampling rate than when an event is not detected***”).

XIII. [GROUND 1C] – FORSTALL, RABU, LANGLE2009, WARREN, AND BALACHANDRAN RENDERS CLAIMS 6, 7, 16, 26, 27, AND 34 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren-Balachandran Combination

168. As discussed in the previous section, Balachandran discloses an exemplary technique where emergency call is initiated by a cellphone in response to detection of a vehicle accident. USAA-1006, Abstract. A POSITA would have been motivated to incorporate this feature into the Forstall-Rabu-Langle2009-Warren combination and thereby enable device 100 to prevent casualties resulting from a vehicle accident.

169. Balachandran’s emergency response technique would have advanced Langle’s overall motivation to reduce casualties resulting from vehicular accidents. For example, the combination would have enabled phone 100 to provide life-saving capabilities by enabling a mechanism for user to seek emergency response service when a vehicle accident occurs while a user is travel along a navigation route. *Id.* Further, because Langle2009 describes that a cellphone is capable of communicating and/or sharing safety evaluation data with other external systems, a

POSITA would have perceived configuring phone 100 to incorporate Balachandran's emergency response techniques as an implementation detail. USAA-1029, Abstract ("mobile phones may be used to aid in safe driving practices and detection of emergencies"). A POSITA would have had a reasonable success in implementing the combination without invention since from my review, several vehicle monitoring systems by the Critical Date were similarly capable of providing emergency response techniques. USAA-1021, USAA-1022, USAA-1023.

B. Analysis

1. Claim 6

[6.1] A mobile telecommunications device according to claim 2, wherein the predetermined action comprises providing feedback to a user to indicate that an event has been detected,

170. Balachandran describes sensors configured to detect an accident ("**an event [that] has been detected**"). USAA-1007, 2:16-27, 4:5-21. As discussed in Section XIII.A, upon detecting an accident, Balachandran's emergency response technique involves an emergency call activation signal being transmitted to a cellphone, which initiates an emergency call after a timeout period specified by a timer has expired. *Id.*, Abstract, 2:64-3:6. Notifications relating to timer 35 are used to indicate an accident has been detected since timer 35 is specifically used to initiate an emergency call relating to a detected accident. Thus, a POSITA would

have found it obvious that the device of the combination provides an audio or visual output to indicate that an accident has been detected (“***providing feedback to a user***”). Further, in some instances, an accident is detected (and an audible or visual notification of the detected accident is provided) in response to device identifying an unsafe driving behavior (“***occurrence of a predetermined event***”). USAA-1029, 1.

171. A POSITA would have also found it obvious to configure the phone of the combination to provide visual notifications relating to accident detection since the device provided by the combination already includes a touch screen (as discussed for [1.1] and [1.3]). USAA-1028, [0051]. Balachandran describes an interface 45 enabling a user to interact with a cellphone after detection of an accident and a POSITA would have recognized that touch screens were ubiquitous for enabling device-user interaction in mobile device-based accident systems by the Critical Date. USAA-1007, 2:64-3:6; USAA-1008, 32-34. For example, Thompson²⁰¹⁰ describes using a smartphone (a touchscreen-enabled device) for detecting an accident and enabling user interactions in relation to an accident. USAA-1008, 32-34. A POSITA would have therefore found it obvious to implement interface 45 as a visual interface and enable user interaction (e.g., interactive notifications) through a touch screen of the device. *Id.* A POSITA would have therefore found it obvious to implement interface 45 as a visual

interface and enable user interaction (e.g., interactive notifications) through a touch screen of the device provided by the combination. *Id.*; USAA-1028, [0051]-[0053].

[6.2] the mobile telecommunications device being configured to receive a user interaction to confirm or deny whether the detected event has actually occurred following said feedback.

172. As discussed for [6.1], in the Forstall-Rabu-Langle2009-Warren-Balachandran combination, a POSITA would have found it obvious to implement interface 45 as a visual interface to enable user interaction (e.g., interactive notifications) through a touch screen. USAA-1007, 2:64-3:6; 8:5-18; USAA-1008, 32-34. A POSITA would have found it obvious that such user interaction involves a user providing input relating to a detected accident (“***receive a user interaction to...deny whether the detected event has actually occurred following said feedback***”) since touch screens were ubiquitous for enabling device-user interaction in mobile device-based accident systems by the Critical Date. USAA-1008, 32-34. Balachandran teaches that the cellphone is capable of providing a “***visual indication*** [that] notifies the passengers of activation of timer” relating a detected accident. USAA-1007, 2:16-63, 4:5-21.

2. *Claim 7*

[7.1] A mobile telecommunications device according to claim 6, wherein the feedback comprises notifying a user that a further action has been scheduled, and will be taken within a predetermined period,

173. As discussed for [6.1], a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Warren-Balachandran device to provide an audio or visual indication that an accident has been detected. Balachandran describes that the indication “notifies the passengers of activation of the timer 35 and ceases with expiration or cutoff of the timer.” USAA-1007, 2:46-63. A POSITA would have also found it obvious to implement interface 45 in the device as a visual interface and enable user interaction (e.g., interactive notifications) through a touch screen of the device. USAA-1028, [0051]-[0053]. The device provided by the combination would have notified a user that an emergency call has been scheduled (“***further action [that] has been scheduled***”) after a time period specified by a timer (the action “***will be taken with a predetermined period***”).

[7.2] the mobile telecommunications device being further configured to receive a user interaction to confirm or deny whether the further scheduled action should be taken within a predetermined period.

174. As discussed for [6.2], in the Forstall-Rabu-Langle2009-Warren-Balachandran combination (see Section XIII.A), a POSITA would have found it obvious to configure a phone to receive a user abort command relating to an emergency call. USAA-1006, 2:64-3:6, 4:22-31. A POSITA would have also

found it obvious to implement interface 45 in the device as a visual interface and enable user interaction (e.g., interactive notifications) through a touch screen of the device. USAA-1028, [0051]-[0053]. The Forstall-Rabu-Langle2009-Warren-Balachandran device would have been configured to receive a user abort command (*“user interaction...to deny whether the further action should be taken”*) relating to an emergency call to be initiated after a time period specified by a timer (the action *“will be taken with a predetermined period”*).

3. Claims 16, 34

[16], [34] wherein the at least one predetermined action comprises providing the user with options to control the mobile device to take further actions.

175. As discussed for [6.1] and [6.2], Balachandran describes initiating a timeout period upon detecting an accident and allowing a user to interact with a cellphone via interface 45 during the timeout period. USAA-1007, 2:16-27. The cellphone provides “[a]n audio or visual indication [that] notifies the passengers of activation of [a] timer 35 and ceases with expiration or cutoff of the timer.” *Id.*, 2:46-63. During the timeout period, the user can “cancel initiation of an emergency call...if no emergency assistance is required.” *Id.*, 2:16-27, 4:5-21. Since cancellation is initiated by the user via interface 45, a POSITA would have found it obvious that interface 45 *“provid[es] the user with [an] option[] to control the mobile device to take further action[]”* (e.g., configuring the cellphone to end timer 35 and cancel initiation of an automated emergency call).

176. A POSITA would have also found it obvious to configure the Forstall-Rabu-Langle2009-Warren-Balachandran device to provide a user with additional options, such as affirmatively confirming, via interface 45, that an accident has occurred. *Id.* A POSITA would have found it obvious to configure interface 45 to provide an option for the user to voluntarily confirm an accident. Such a configuration would have been advantageous as it would allow a cellphone to initiate an emergency call immediately and without requiring expiration of the timeout period, as described in Balachandran. *Id.* Similar configurations of mobile device-based accident detection systems were also well-known by the Critical Date. For example, Thompson2010 describes a mobile device software client that enables several “activities,” which are “basic building block components for Android applications and can be thought of as a ‘screen’ or ‘view’ that provide a single, focused thing a user can do.” USAA-1008, 32-34. Thompson2010 describes “image upload” as an example of an activity and shows that images of an accident can be uploaded from a mobile device for evaluation. *Id.*, 33. A POSITA would have understood that an option to upload an image of an accident is an example of providing the user with an option to control the mobile device to take further action.”

4. *Claims 26, 27*

177. Forstall-Rabu-Langle2009-Warren-Balachandran renders these claims obvious in the same manner as explained above for the corresponding claim limitations listed in the table below.

Claim 1 Limitation	Corresponding Limitations
[26.1]	[6.1]
[26.2]	[6.2]
[27.1]	[7.1]
[27.2]	[7.2]

XIV. [GROUND 1D] – FORSTALL, RABU, LANGLE2009, WARREN, AND KATAYAMA RENDERS CLAIMS 9, 10, 17, 18, 35-38 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren-Katayama Combination

178. A POSITA would have found obvious enhancement of the Forstall-Rabu-Langle2009-Warren device through implementation both of Katayama's teachings on partitioning local memory into several sections (including sections for temporary and long term storage), and related teachings on data handling, including both the comparison at the time of recording of digitalized sensor data against judgment criteria representative of specific driving behaviors, and storage in appropriate sections of memory of digitalized data with metadata identifiers indicating determinations made through those comparisons. USAA-1024, [0012], [0015], [0048], [0049].

179. A POSITA would have reasonably expected the enhancements of the Forstall-Rabu-Langle2009-Warren-Katayama combination to produce multiple benefits. For example, the combination would have provided more effective use of the Forstall-Rabu-Langle2009-Warren-Katayama device's memory given storage constraints of mobile device memory. This would have improved retention of important information for analysis while also allowing continually updating the memory with new sensor data and related information. USAA-1028, [0006], [0008], [0055], [0056]; USAA-1024, [0014]-[0016], [0045], [0053].

180. The combination would have also prevented inadvertent erasure of data from the Forstall-Rabu-Langle2009-Warren-Katayama device's memory that might be useful in assessing driving behavior. USAA-1024, [0001]-[0002], [0016], [0045]-[0050]. As discussed in Section X.A.7, Katayama describes a memory architecture and data handling techniques that permit the partitioning of data temporarily stored in a temporary section and important data being stored for longer time periods in a storage section. Because the Forstall-Rabu-Langle2009-Warren-Katayama device is used for driver monitoring using sensor data collected by embedded sensors of the device, a POSITA would have recognized that the partitioning described in Katayama is a suitable solution to prevent erasure of potentially important data.

181. Additionally, the combination enables generation of more sophisticated and accurate predictions derived from information further indicating whether a driver may have been involved in an accident or “risk incident.” USAA-1029, 1-3; USAA-1024, [0044]-[0046]. A POSITA would have understood that Katayama’s techniques of detecting accidents or risk incidents advances Langle2009’s overall motivation to “enhance and strengthen its emergency services” such that “mobile phones may be used to aid in safe driving practices and detection of emergencies.” USAA-1029, Abstract. The combination further enables association of a detected unsafe driving behavior (as described in Langle2009) and a detected risk incident (as described in Katayama), thereby enabling confirmation of correlations between certain driving behaviors (unsafe accelerations, unsafe lane changing) and occurrence of risk accidents.

182. Another improvement is after-the-fact accident reconstruction utilizing the Forstall-Rabu-Langle2009-Warren-Katayama device in support of, for example, real-time route navigation. USAA-1028, [0006]; USAA-1024, [0027], [0031]). The combination would have enabled the detection of accidents or risk incidents while a user is navigating along a navigational route, which enables aggregation of data collected for multiple users and identification of route portions that are likely to cause subsequent occurrence of risk incidents.

183. A POSITA would have understood and found obvious that, like Katayama's local memory 82, the local memory featured in Forstall's "device 100" (and in the Forstall-Rabu-Langle2009 device) has limited capacity, and must accommodate within that limited capacity continuously and sequentially received information including sensor data. *See* USAA-1028, [0055]-[0057].

184. Forstall explains, for example, that "a device position is stored in memory[,] along with "[s]ensor data [] received from a motion sensor measuring movement of the device." USAA-1028, [0006], [0075]. Forstall also describes processing of this data, for example, that "[a]n estimated current device location is determined[,] based on "the device position, received sensor data, and an interpretation of the received sensor data as corresponding to movement along at least one pathway defined by the map data." *Id.*, [0006]. As discussed in Section X.A.3, Langle2009 further describes techniques to "classify safe versus unsafe driving[]" using sensor data collected by a phone, such as "[braking] distance, acceleration, and deceleration[.]" USAA-1029, 1. From this and related description, a POSITA would have understood and found obvious that driving safety information derived from sensor data is stored locally in a memory on the Forstall-Rabu-Langle2009-Warren device for analysis. USAA-1029, 1 ("[u]sing accelerometer measurements, it should be possible to classify driving habits as safe or unsafe").

185. A POSITA would have recognized that important information stored in the local memory of the devices of Forstall and Langle2009 are subject to the risk of being inadvertently erased and overwritten with new data, and would have recognized in Katayama's teachings a solution that could be readily applied in the context of the Forstall-Rabu-Langle2009 device: bifurcation of the local memory into temporary and long term sections, with storage of information identified as important in the long term section. USAA-1024, [0001]-[0002], [0016], [0044]-[0051], [0057].

186. A POSITA would have also recognized that configuring the Forstall-Rabu-Langle2009-Warren device's memory in this manner while generally applying Katayama's related data storage techniques would "enable[] effective use of the memory without erasing important situation data" and "eliminat[e] accumulation of useless data," while at the same time furthering Langle2009's goals of "aid[ing] in safe driving practices and detection of emergencies" and "classify[ing] safe versus unsafe driving" by enabling the Forstall-Rabu-Langle2009 device to detect both accidents and "risk incidents." USAA-1029, Abstract, 1; USAA-1024, [0016], [0053], [0044], [0046].

187. As taught by Katayama, the POSITA would have configured the Forstall-Rabu-Langle2009-Warren device to receive "situation data" including sensor data "at a constant sampling time one after another in a chronological

order,” and to write “the received situation data” in a temporary data storage section within the Forstall-Rabu-Langle2009-Warren device’s local memory. USAA-1024, [0016], [0044]-[0049]. To avoid erasure of situation data that might be useful in determining the cause of an accident or risk incident, or in otherwise analyzing driving behavior as taught by Langle2009, the POSITA would have further configured the Forstall-Rabu-Langle2009-Warren device to “digitalize” temporarily stored situation data for purposes of determining, at the “time of recording,” whether that digitalized situation data meets one or more predetermined criteria for long term storage (for example, whether a value of temporarily stored digitalized accelerometer data exceeds a predetermined threshold). USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083].

188. Consistent with Katayama’s teachings, the POSITA would have configured the Forstall-Rabu-Langle2009-Warren device to record situation data determined to be “important” with a metadata “identifier” marking it as such, and to transfer situation data with the identifier from the local memory’s temporary storage to its long term recording section.” USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083]. And, again consistent with Katayama’s teachings, the POSITA would have configured the Forstall-Rabu-Langle2009 device to store situation data determined to be less than important with

a metadata “identifier” marking it as such, until such time as the unimportant situation data is overwritten with new data. USAA-1024, [0011]-[0016], [0054].

189. As noted above, a POSITA would have understood and found obvious that the Forstall-Rabu-Langle2009-Warren-Katayama device resulting from these collective enhancements would, in comparison with the Forstall-Rabu-Langle2009-Warren device, enjoy improved data management with reduced likelihood of erasure of important data. USAA-1028, [0055]-[0057]; USAA-1024, [0014]-[0016], [0045], [0053]. Further, the POSITA would have understood and found obvious that the above enhancements would improve Langle2009’s driving safety monitoring techniques, by enabling identification of accidents and “risk incidents”, with corresponding improvements to the sophistication of driving safety metrics.⁷ USAA-1029, 1-3; USAA-1024, [0044]-[0046].

⁷ For example, a POSITA would have recognized that Katayama’s techniques for managing “situation data” would advantageously enable the Forstall-Rabu-Langle2009 device to determine the “surrounding situation or the like of a motor vehicle during a certain period before and after a time of an accident or...risk incident,” and to “very easily and accurately[,]” enable “after-the-fact analysis” of accidents and risk incidents by third parties. USAA-1024, [0001], [0027].

190. These among other advantages would have amply motivated a POSITA to integrate Katayama's teachings into the Forstall-Rabu-Langle2009-Warren device. USAA-1028, [0055]-[0057]; USAA-1029, 1-3; USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0044]-[0050], [0054], [0083]. For example, the combination would have provided more effective use of the Forstall-Rabu-Langle2009-Warren-Katayama device's local memory given storage constraints of device memory. This would have improved retention of important information for analysis while also allowing continuous updates to the memory with new sensor data and related information. USAA-1028, [0006], [0008], [0055], [0056]; USAA-1024, [0014]-[0016], [0045], [0053].

191. The combination would have also prevented inadvertent erasure of data from the Forstall-Rabu-Langle2009-Warren-Katayama device's local memory that might be useful in assessing driving behavior. USAA-1024, [0001]-[0002], [0016], [0045]-[0050]. As discussed in Section X.A.7, Katayama describes a memory architecture and data handling techniques that permit the partitioning of data temporarily stored in a temporary section and important data being stored for longer time periods in a storage section. Because the Forstall-Rabu-Langle2009-Warren-Katayama device is used for driver monitoring using sensor data collected by embedded sensors of the device, a POSITA would have recognized that the

partitioning described in Katayama is a suitable solution to prevent erasure of potentially important data.

192. Additionally, the combination enables generation of more sophisticated and accurate user driving scores derived from information further indicating whether a driver may have been involved in an accident or “risk incident.” USAA-1029, 1-3; USAA-1024, [0044]-[0046].

193. The combination would have also enabled an improved after-the-fact accident reconstruction by third parties utilizing the Forstall-Rabu-Langle2009-Warren-Katayama device in support of, for example, legal and insurance-related inquiries. USAA-1028, [0006]; USAA-1024, [0027], [0031]. The combination would have enabled the detection of accidents or risk incidents while a user is performing actions while driving, which enables aggregation of data collected for multiple users and confirmation of specific driver behaviors (texting while driving, talking on the phone while driving) that are likely to cause subsequent occurrence of risk incidents.

194. Configuring the Forstall-Rabu-Langle2009 device to leverage Katayama’s teachings would have required only routine knowledge of programming and common electronic components. This was well within the skill of a POSITA prior to the earliest effective filing date. The changes would have amounted to the use of known techniques to improve similar devices. In each

instance, a device for recording and analyzing driving information equipped with a sensor set and a form of electronic storage in a similar way, and combining prior art elements according to known methods to yield the predictable results described above.

195. The elements of the resulting combination would each perform functions they had been known to perform prior to the combination. Forstall's device 100 would store sensor data and related information but, in the specific manner taught by Katayama, would identify and preserve information determined to be important in a form of long-term storage. A POSITA would have naturally expected success when incorporating Katayama's teachings into the Forstall-Rabu-Langle2009-Warren device.

B. Analysis

1. Claims 9, 35

[9.1], [35.1] A mobile telecommunications device according to claim 2, wherein the memory comprises: a long term memory for persistently storing driving information and a short term memory for transiently storing driving information,

196. As discussed above (Section XIV.A), the POSITA would have configured the Forstall-Rabu-Langle2009-Warren-Katayama device's memory ("**memory**") to feature several sections according to, and facilitating use of Katayama's teachings on data management, including a temporary section ("**short term memory**") and a storage section ("**long term memory**"). USAA-1024, [0044];

USAA-1028, [0055]-[0057]. As further noted, implementation of Katayama's teachings on memory architecture and data management enable the Forstall-Rabu-Langle2009-Warren device to, among other things, achieve several benefits, including the ability to retain (i.e., store over long time periods) data indicating unsafe driving behaviors in the storage section while also ensuring sufficient capacity to store data in the temporary section. USAA-1024, [0045]; USAA-1028, [0055]-[0057], Fig. 3.

197. As explained for [1.7], the Forstall-Rabu-Langle2009-Warren-Katayama device processes sensor data to derive "driver safety" information, as described in Langle2009. USAA-1029, 1-3. Further, as taught by Katayama, the Forstall-Rabu-Langle2009-Warren-Katayama device would receive "situation data" including sensor data "at a constant sampling time one after another in a chronological order," and write "the received situation data" in a temporary section within the Forstall-Rabu-Langle2009-Warren-Katayama device's memory. USAA-1024, [0016], [0044]-[0049].

198. To avoid erasure of situation data that might be useful in determining the cause of an accident or risk incident, or in otherwise analyzing driving behavior as taught by Langle2009, the POSITA would have further configured the Forstall-Rabu-Langle2009-Warren device to "digitalize" temporarily stored situation data for purposes of determining, at the "time of recording," whether that digitalized

situation data meets one or more predetermined criteria for long term storage.

USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083].

199. Consistent with Katayama's teachings, the POSITA would have configured the Forstall-Rabu-Langle2009-Warren-Katayama device to record situation data determined to be "important" with a metadata "identifier" marking it as such, and to transfer situation data with that identifier from the local memory's temporary storage to its long term recording section." USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083]. More specifically, the important situation data would be retained to enable "after-the-fact analysis" of, for example, accidents and risk incidents, and would for at least that reason be understood as being "***persistently***" stored. USAA-1024, [0001], [0027], [0046]-[0052].

200. A POSITA would have configured the Forstall-Rabu-Langle2009-Warren-Katayama device to temporarily store situation data determined to be less than important with a metadata "identifier" marking it as such, until such time as the unimportant situation data is overwritten with new data. USAA-1024, [0011]-[0016], [0054]. More specifically, the unimportant situation data would be "sequentially erased" as "new situation data is written[,]" and would for at least that reason be understood as being "***transiently***" stored. USAA-1024, [0045].

201. From Katayama, the POSITA would have understood and found obvious that both the digitalized “situation data” transiently stored in the Forstall-Rabu-Langle2009-Warren-Katayama device’s short term memory section and the digitalized “situation data” persistently stored in the Forstall-Rabu-Langle2009-Warren-Katayama device’s long term memory section are derived by processing sensor data received during a driving period (e.g., the driving period discussed above in connection with [1.6]), and constitute “***driving information***” associated with how a vehicle is driven. USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083].

202. Further, the POSITA would have understood and found obvious from Katayama that the metadata identifiers that are, respectively, transiently and persistently stored in the Forstall-Rabu-Langle2009-Warren-Katayama device’s short term and long term memory sections themselves constitute “***driving information***” that is associated with how a vehicle is driven and that is derived by processing sensor data received during a driving period. USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083]. Katayama suggests, for example, that an identifier marking a particular set of digitalized accelerometer data as “important” may be generated and stored as result of determinations that a value of that digitalized accelerometer data exceeds a predetermined threshold, and that the acceleration continued over a certain period of time. USAA-1024, [0047]-

[0049]. Katayama also describes use of selection signals that may be understood to represent driving information given their use in transferring information deemed important to the long term storage section. USAA-1024, [0063], [0067], [0068]-[0071].

203. For at least these reasons, the POSITA would have understood that the Forstall-Rabu-Langle2009-Warren-Katayama phone transiently stores driving information in short term memory, and persistently stores driving information in long term memory. USAA-1024, [0001]-[0002], [0011]-[0016], [0027], [0046]-[0050], [0054], [0083].

204. Katayama also render this limitation obvious through disclosures of various storage configurations. Katayama contemplates a storage configuration in which “old data is sequentially erased and new situation data is written in the temporary data storage section[.]” USAA-1024, [0045]. Further, where “content meets the predetermined condition,” the corresponding content is “transferred” from section 802 (temporary section) section 803 (storage section). *Id.*, [0046]. Because Katayama contemplates scenarios that benefit from persistent and temporary storage of recorded data, a POSITA would have found such configurations obvious over its disclosure.

205. Additionally or alternatively, a POSITA would have recognized and/or found obvious to leverage Katayama’s techniques of using different types or

areas of memory for “temporarily stor[ing]” data in one memory location, e.g., a temporary storage section 802 and for long term storage of data, in another memory location, e.g., situation data recording section 803 in the Forstall-Rabu-Langle2009-Warren-Katayama combination. USAA-1027, 63-65; USAA-1037, [0042]-[0043]; USAA-1038, [0043], [0046]); USAA-1024, [0044]-[0046], [0051], [0053], Fig. 5.

206. It had been common knowledge to a POSITA that a computer system uses a “hierarchical memory” that includes “a combination of memory types to provide the best performance at the best cost.” USAA-1027, 64. The hierarchical memory include different areas using different types of memories that have different access speeds and storage capabilities. Common types of memories “constitute the hierarchical memory includes registers, caches, main memory and secondary memory.” Among them, cache is a short term memory, “where data from frequently used memory location may be temporarily stored.” *Id.* Cache can be implemented by volatile memory such as SRAM (static random access memory). *Id.* The main memory “is typically a medium-speed memory, complemented by a very large second-ary memory.” In some instances, the main memory can be implemented by volatile memory, while the secondary memory can be implemented by non-volatile memory such as ROM (read only memory) (e.g., hard disk) that persistently stores data “does not need to change” and “data

recorded on them lasts longer than it would in volatile main memory.” USAA-1027, 64-65; USAA-1037, [0042]-[0043]; USAA-1038, [0043], [0046]. A POSITA would have found obvious that different types of memories can be combined and configured to balance the access speed, storage capacity, and cost given different use cases and system requirements.

207. A POSITA reading Katayama would have also realized Katayama’s uses of the temporary storage and storage section is consistent with the convention of a computer’s “hierarchical memory” that includes “a combination of memory types memory to provide the best performance at the best cost.” USAA-1027, 64. A POSITA would have found obvious that different types of memory (e.g., RAM, ROM, or a combination of both) can be used to implement Katayama’s storage section and storage section as long as they meet the functionality of the temporary section for temporarily storing data and the functionality of the storage section for long term storing data, as well as any other design criteria (e.g., cost, access speed, and capacity). USAA-1024, [0044]-[0046], [0051], [0053], Fig. 5; USAA-1027, 64-65.

[9.2], [35.2] wherein the short term memory receives driving information at a higher update rate than the long term memory,

208. As discussed in [9.1], the Forstall-RabuLangle2009-Warren-Katayama device’s memory includes a temporary section (“***short term memory***”)

and a storage section (“***long term memory***”) that together enable implementation of Katayama’s data storage techniques. USAA-1024, [0044]; USAA-1028, [0055]-[0057]; USAA-1029, 1-3. Katayama further teaches that the situation data is written “at a constant sampling time one after another in a chronological order and writes the received situation data one after another in the temporary data storage section[.]” USAA-1024, [0045].

209. A POSITA would have understood and found obvious that the situation data sequentially written to the temporary section “one after another” includes both sensor data and information derived therefrom (digitalized data, metadata identifiers) given Katayama’s broader disclosure of the situation data being “automatically classified at a time of recording.” USAA-1024, [0016]. Katayama teaches that this configuration, “make[s] after-the-fact analysis accurately and easily” and further recognizes that such a configuration ensures that “important data will not be erased” despite circumstances where “a capacity of a memory runs out.” USAA-1024, [0016]. Given that the digitalization of sensor data values and metadata identifiers enables the importance categorizations of situation data—which Katayama teaches permits the prioritization of situation data to be transferred to the storage section for further evaluation in the after-the-fact analysis—a POSITA would have found it advantageous to implement Katayama’s data handling techniques such that these specific portions of situation data are

similarly written into the temporary section at one after another in the temporary section.

210. In discussing digitalization, Katayama teaches that “all” situation data recorded in section is digitalized, and then reinforces this a list of non-limiting examples of the types of data that are digitalized. USAA-1024, [0048]. This would have informed a POSITA that digitalization is important to Katayama’s data handling technique. Further, since the purpose of data stored in long-term storage is to perform an after-the-fact analysis relating to a risk incident or an accident, a POSITA would have found obvious that storage of digitalized values in section 803 embraces this purpose, and further enhances the after-the-fact analysis. This configuration enables digitalized values in section 803 to be leveraged in the same way as the analysis used to determine whether situation data in section 802 is important enough to be transferred to section 803.

211. Katayama further recognizes that, in the context of after-the-fact analyses of an event that may represent accident detection, “the situation data before and after this event is set to be in a category of, for example, an accident and **the most important**.” USAA-1024, [0015]. The digitalized values are used for evaluation and a POSITA would have found it contrary to the purpose of Katayama’s data handling techniques to only use these generated values for the

purposes of determining their significances and then discarding them when storing in section 803.

212. From the disclosure above, a POSITA would have found obvious that the temporary section receives situation data, including sensor data and derived information (digitalized data, metadata identifiers). Further, the temporary section obtains data more frequently (“***receives driving information at a higher update rate***”) than the long term storage section. USAA-1024, [0044]-[0046], Fig. 5.

213. For instance, “the [temporary section] temporarily stores the situation data irrespective of the contents of the situation data while the [storage section] stores the situation data for the record basically without updating the situation data...” USAA-1024, [0051]. Situation data is transferred to the storage section “[o]nly in a case that the content meets the predetermined condition[.]” *Id.*, [0046]. Further, “[i]f a capacity of the [temporary section] runs out, old data is sequentially erased and new situation data is written in the [storage section].” *Id.*, [0045]. In scenarios where data is periodically recorded but no accident is detected, old data stored in the temporary section is more frequently erased relative to situation data transferred to the storage section.

[9.3], [35.3] the mobile telecommunications device being further configured to: write driving information to the short term memory at a predetermined update rate during the driving period in a predetermined sequence; and,

214. As discussed above, memory of the Forstall-Rabu-Langle2009-Warren-Katayama device includes a storage section and a temporary section to provide the enhance storage capabilities and data management techniques described in Katayama. USAA-1024, [0044]; USAA-1028, [0055]-[0057]; USAA-1029, 1-3. Further, as explained in Section XIV.A, the memory of the Forstall-Rabu-Langle2009-Warren-Katayama device incorporates Katayama's related data handling teachings, including both (i) the comparison at the time of recording of digitalized sensor data against judgment criteria representative of specific driving behaviors, and (ii) storage in appropriate sections of memory of digitalized data with metadata identifiers indicating determinations made through those comparisons. USAA-1024, [0012], [0015], [0048], [0049].

215. As to comparisons to judgement criteria, Katayama describes that "the value (the content) of each situation data is, for example, digitalized in accordance with [a] judgment criterion parameter." USAA-1024, [0048]. Further, "all" situation data is digitalized, to represent various types of information, such as "whether or not the acceleration (deceleration) exceeds a predetermined judgment criterion, whether or not the acceleration continues for more than or equal to a certain period, whether or not the door is open, whether or nor the electric power is

supplied from the battery, whether or not the speed of the vehicle exceeds the predetermined upper limit speed, whether or not the speed of the vehicle is not over the predetermined lower limit speed and whether or not the brake is applied.”

Id.

216. As to storage of digitalized data in appropriate sections of memory, Katayama describes “giv[ing] an identifier to each situation data according to [a] category” that “may be specified according to an event that is estimated to have occurred[.]” *Id.*, [0012]. The identifier enables a recording device to “store the situation data into a folder (a category) specified” in storage. *Id.*

217. Based on the disclosures above, a POSITA would have understood and found obvious that derived information within the situation data, such as digitalized data and associated metadata identifiers reflecting importance classifications, are each written in the temporary section. Given Katayama’s broader teaching that “the situation data is automatically classified at a time of recording,” a POSITA would have found obvious that digitalized values are similarly generated during recording since classification is enabled through the comparison of digitalized values to predetermined judgement criterion. *Id.*; USAA-1024, [0048], [0049]. Further, because situation data temporarily stored in the temporary section is evaluated for importance in determining whether the temporarily-stored data should be transferred to the storage section, a POSITA

would have found it obvious that the metadata identifiers (which provide importance information), would have similarly been stored in the temporary section. USAA-1024, [0046].

218. Further, as explained above for [9.1] and [9.2], a POSITA would have understood and found obvious that the situation data, including sensor data and derived information (digitalized data, metadata identifiers) is sequentially written to the temporary section “one after another” given Katayama’s broader disclosure of the situation data being “automatically classified at a time of recording.” USAA-1024, [0016]. A POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Warren-Katayama device to write derived information specified in situation data (digitalized values, metadata identifiers) in the temporary section (“***write driving information to the short term memory***”). Additionally, based on the predetermined sampling rate of sensor data collection, it would have further been obvious that derived information is written to the temporary section at a corresponding predetermined update rate (“***predetermined update rate***”) and while a vehicle is monitored according to a chronological order (“***predetermined sequence***”). USAA-1024, [0044]-[0046], Fig. 5.

219. Thus, a POSITA obvious the Forstall-Rabu-Langle2009-Warren-Katayama device writes derived information specified in situation data (digitalized values, metadata identifiers) in the temporary section (“***write driving information***”).

to the short term memory”). Katayama further teaches writing situation data “at a constant sampling time one after another in a chronological order and writes the received situation data one after another in the temporary data storage section[.]” *Id.*, [0045]. In the Forstall-Rabu-Langle2009-Warren-Katayama device writes the derived information specified in the situation data (digitalized values, metadata identifiers) at a constant sampling rate (“*predetermined update rate*”) and while a vehicle is monitored according to a chronological order (“*predetermined sequence*”). USAA-1024, [0044]-[0046], Fig. 5.

220. A POSITA would have also understood that predetermined sampling of sensor data involves a predetermined update rate of writing associated data during a driving period into storage since similar storage configurations were well-known by the Critical Date. USAA-1027, 70-71. A POSITA would have perceived Katayama as teaching recording the data during the driving period because the recorded data includes “data concerning the behavior, the surrounding situation or the like of the motor vehicle V” that is recorded “during a certain period before and after a time of an accident or a hiyari hatto (risk incident),” and can even be “classified at a time of recording.” USAA-1024, [0001], [0016].

[9.4], [35.4] overwrite the driving information previously written to the short term memory in accordance with the predetermined sequence.

221. As discussed above for [9.1], the POSITA would have configured the Forstall-Rabu-Langle2009-Warren-Katayama device's memory to feature both short term and long term storage sections, and would have further implemented Katayama's teachings on overwriting "situation data" including driving information previously written to the short term memory in accordance with the predetermined sequence as new situation data is derived. USAA-1024, [0046]. As discussed in Section XIV.A, this configuration enables the Forstall-Rabu-Langle2009-Warren-Katayama device to "eliminat[e] accumulation of useless data" and to make "effective use of the memory without erasing important situation data," while at the same time furthering Langle2009's goals of "classify[ing] safe and unsafe lane changes." USAA-1029, Abstract; USAA-1024, [0016], [0053], [0044], [0046].

222. For example, the Forstall-Rabu-Langle2009-Warren-Katayama device would leverage Katayama's teaching that "[i]f a capacity of the [short term memory section]...runs out, old data is sequentially erased and new situation data is written in" to the short term memory section. USAA-1024, [0045]. A POSITA would have understood that, being "***sequentially*** erased," the old data is erased according to the chronological order in which it was written into the short term

memory section, which is First in, First Out (“FIFO”), a typical replacement policy commonly used to overwrite old data in a memory when the memory is full.

USAA-1027, 70-71; USAA-1039, [0003]-[0004]. Claims 2-4, 7, 10-12, 16, 17, 19-24.

2. *Claims 10, 36*

[10.1], [36.1] A mobile telecommunications device according to claim 9, wherein the mobile telecommunications device is controlled by the downloaded application to control the mobile device to detect an occurrence of a predetermined event and

223. As discussed for [2] (see Section XIV.A), a POSITA would have configured device 100 to classify driving behaviors based on sensor data, and POSITA would have understood detection of a particular driving behavior to represent “***detect occurrence of a predetermined event.***” USAA-1029, 502; USAA-1030, [0051].

[10.2], [36.2] in response transfer data from the short term memory to the long term memory.

224. Katayama describes transferring situation data (“***data***”) from temporary data storage section 802 (“***short term memory***”) to situation data recording section 803 (“***long term memory***”) in response to satisfaction of predetermined conditions associated with accident detection. USAA-1024, [0046]. The conditions can relate to acceleration data, such as “whether or not the acceleration (deceleration) exceeds a predetermined judgement criterion,” or

“whether or not the acceleration continues for more than or equal to a certain period[.]” *Id.*, [0048]. In circumstances where an accident is detected based on acceleration data that also satisfies a predetermined condition for transfer, the situation data is transferred from temporary data storage section 802 to situation data recording section 803 “***in response to***” the accident being detected.

3. *Claims 17, 37*

[17.1], [37.1] A mobile telecommunications device according to claim 1, further configured to: interface with an external device, the external device having access to external driving information associated with a condition of the vehicle; and,

225. Katayama describes a set of vehicle sensors (“***external device***”) that sense data related to “the behavior, surrounding situation, and operating condition or the like of [a] motor vehicle V” (“***external driving information associated with a condition of the vehicle***”). USAA-1024, [0034], [0064]. Examples of the vehicle sensors include “automobile speed meter 10 incorporated into the vehicle, the door 11, the emergency brake 12 and the ignition switch 13.” *Id.*, [0064]. Thus, the Forstall-Rabu-Langle2009-Warren-Katayama device would have obtained data from vehicle sensors as this would have improved the accuracy of monitoring for unsafe driving behaviors.

[17.2], [37.2] to receive at least a portion of the external driving information from the external device.

226. As discussed for [17.1], Katayama describes the data used for accident detection includes “position data indicating a position of the vehicle, speed data indicating a speed of the vehicle, brake data indicating whether or not a brake of the vehicle is activated, door open/close data indicating whether a door is open or closed” (“***at least a portion of the external driving information***”). Given that Katayama teaches using data collected by external vehicle sensors to detect accidents, a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Warren-Katayama device would have received at least a portion of the data collected by external vehicle sensors (“***external device***”).

4. *Claims 18, 38*

[18], [38] A mobile telecommunications device according to claim 17, further arranged to interface with the external device wirelessly.

227. In the Forstall-Rabu-Langle2009-Warren-Katayama combination (see Section XIV.A), a POSITA would have configured device 100 (“***mobile telecommunications device***”) to communicate wirelessly with external vehicle sensors (“***arranged to interface with the external device wirelessly***”). Katayama describes that driving recorder 1 receives data collected by external vehicle sensors (e.g., vehicle speed data, door open/close data, brake data). USAA-1024, [0038]. A POSITA would have understood and/or found obvious to configure device 100 to

implement a wireless connection with the external vehicle sensors since Katayama's recorder 1 and Forstall's device 100 each include wireless modules configured to enable wireless communication with other devices. USAA-1028, [0038] ("wireless communication subsystems"); USAA-1024, [0074] (describing use of a wireless LAN). Indeed, a POSITA would have reasonably expected to succeed in implementing this configuration since wireless communication between a mobile device and external vehicle sensors was a well-known by the Critical Date in vehicle monitoring systems. This is demonstrated by Callopy and a system to communicate vehicle data ("information related to travel in an automobile") from the vehicle ("driving behavior component[s] installed in the automobile") to a computing device ("cellular phone") via a "wired or wireless medium." USAA-1045, [00117], [00178], FIG. 41-43.

XV. [GROUND 1E] – FORSTALL, RABU, LANGLE2009, WARREN, AND THOMPSON2010 RENDERS CLAIMS 14, 15, 32, AND 33 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren-Thompson2010 Combination

228. As discussed in the previous section, Thompson2010 describes techniques for using smartphone system sensors, such as GPS sensors and accelerometers, to provide smartphone-based accident detection. USAA-1008, 30, Fig. 2. A POSITA would have been motivated to incorporate this feature into the

Forstall-Rabu-Langle2009-Warren combination and thereby configure device 100 to prevent casualties that may result from a vehicle accident.

229. Thompson2010's accident detection technique would have advanced Langle's overall motivation to "enhance safety" using "embedded accelerometers" of mobile devices to provide "risk level detection while riding in a vehicle."

USAA-1028, 502. This combination would have enabled motion recording technique to achieve advantages that Thompson2010 describes for smartphone-based accident detection, including "reduc[ing] overall traffic congestion and increas[ing] the preparedness of emergency responders." USAA-1008, Abstract.

Further, because Forstall teaches that memory of device 100 stores "communication instructions" to permit communications with "one or more servers[,] a POSITA would have perceived incorporating Thompson2010's client-server architecture as an implementation detail. USAA-1028, [0056]; USAA-1008, 30, 33-34. A POSITA would have also had a reasonable success in implementing the combination without invention since accident detection using smartphones was well-known by the Critical Date. USAA-1007.

B. Analysis

1. Claims 14, 32

[14.1], [32.1] A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to detect the occurrence of a predetermined event of significance, such as a crash, and

230. Thompson2010 describes a smartphone that detects traffic accidents (“***detect the occurrence of a predetermined event of significance, such as a crash***”). USAA-1008, 30. In the Forstall-Rabu-Langle2009-Warren-Thompson2010 combination (see Section XV.A), a POSITA would have configured device 100 to perform Thompson2010’s accident detection technique and thereby detect traffic accidents. Thompson2010 describes this is accomplished using “sensors built into a smartphone to detect a major acceleration event indicative of an accident and utilize the built-in 3G data connection to transmit that information to a central server.” USAA-1008, 30.

[14.2], [32.2] in response to store driving information associated with that event to the memory.

231. As discussed for [1.8] (see Section XI.B), a POSITA would have configured memory of device 100 (e.g., memory 350) to store driving safety. USAA-1028, [0056]. Further, in the combination with Thompson2010 (Section XV.A), a POSITA would have configured the memory to store sensor information indicating a traffic accident using Thompson2010’s accident detection technique (“***store driving information associated with that event to the memory***”). *Id.*,

[0006], [0055], [0056]. Memory of device 100 stores various information, including a “device position” (USAA-1028, [0008]), “sensor data” and “map data” (*id.*, [0075]), and “instructions for handling basic system services and performing hardware dependent tasks” (*id.*, [0055]). Thompson2010 describes that a smartphone executes a “WreckWatch Android client” that runs “[b]ackground services [that] detect accidents by polling smartphone system sensors, such as the GPS receiver and accelerometers[,]” where “[t]he polling rate is configurable at compile-time to meet user needs and to provide the appropriate consumption characteristics.” USAA-1008, 33. Given these disclosures, a POSITA would have found it obvious to configure memory of device 100 to store raw sensor data used for accident detection (e.g., GPS data, accelerometer data) and data generated through the processing of raw sensor data by device 100 in detecting a traffic accident. Further, a POSITA would have recognized Thompson2010’s disclosure of accident image upload to a server suggests that the uploaded accident images (and associated accident information) are at least temporarily stored in memory prior to upload. USAA-1008, 32, Fig. 4.

2. *Claims 15, 33*

[15.1], [33.1] A mobile telecommunications device according to claim 2, wherein the device is controlled by the downloaded application to detect the occurrence of a predetermined event of significance, such as a crash, and

232. *See [14.1], supra.*

[15.2], [33.2] in response to transmit driving information associated with that event via the wireless telecommunication module to a remote data-logging system.

233. Thompson2010 describes that a mobile client on a smartphone (WreckWatch client) uploads (“***transmit***”) data associated with a detected accident (“***driving information associated with that event***”) to an associated server (WreckWatch server) (“***a remote data-logging system***”). USAA-1008, 30. In the Forstall-Rabu-Langle2009-Warren-Thompson2010 combination (see Section XV.A), a POSITA would have configured Forstall’s system to incorporate a similar client-server architecture such that the navigation application of device 100 provides similar functionality as the WreckWatch client, and a server providing basic services to the navigation application provides similar functionality as the WreckWatch server. USAA-1029, [0040]-[0045]. Forstall contemplates such a configuration since memory of device 100 “store[s] communication instructions 354 to facilitate communicating with one or more additional devices,” such as “one or more servers.” *Id.*, [0056]. Thus, a POSITA would have found it obvious to configure the navigation application of device 100 with functionality for uploading data associated with a detected accident to server 104 (as taught in Thompson). *Id.*; USAA-1008, 30, 32-35.

XVI. [GROUND 1F] – FORSTALL, RABU, LANGLE2009, WARREN AND WILLIS RENDER CLAIMS 45, 50, 53 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren-Willis Combination

234. Device 100 includes “one or more wireless communication subsystems,” such as a “Bluetooth[] communication device 188.” USAA-1028, [0038]. A POSITA would have understood that “Bluetooth” means “the industrial specification for wireless personal area networks that provides a mechanism for exchanging information between cell phones, pocket PCs, PDAs, and the like.” USAA-1009, 9:22-24. A POSITA would have also understood that

235. A POSITA would have also understood that proximity detection based on Bluetooth signal strengths (as described in Willis) is an implementation detail and/or obvious design choice of many (if not all) Bluetooth sensors of mobile devices. Willis describes that its techniques involve “[t]he use of core Bluetooth™ functionality [that] enables the invention to be used with a broad range of Bluetooth™ capable devices and avoids the incompatibility issues suffered by predecessor devices.” USAA-1009, 31:6-8. Further, “a POSITA would have understood that ‘Bluetooth’ refers to an industrial specification that is standardized across devices with Bluetooth functionality and Willis’ disclosure of using Bluetooth signal strength to detect proximity of a nearby device is within the scope of the industrial specification.” Thus, a POSITA would have found it

obvious that Bluetooth communication device 188 of device 100 detects a proximity of a car using “the signal strength of the Bluetooth receiver inside [the] car,” as described in Willis. USAA-1009, 19:10-14.

B. Analysis

1. Claims 45, 50, 53

[45.1], [50.1], [53.1] A non-transitory computer readable medium according to claim 21, wherein the mobile telecommunications device further comprises a proximity sensor and

236. Willis describes a mobile device includes a Bluetooth sensor (“***proximity sensor***”) that detects proximity of a nearby vehicle using Bluetooth signal strength. USAA-1009, 1:23-27, 14:25-15:3. Device 100 includes Bluetooth communication device 188 and, in the combination with Willis (*see* Section XVI.A), a POSITA would have configured Bluetooth communication device 188 to detect proximity of a vehicle (as taught in Willis). *Id.*

[45.2], [50.2], [53.2] the instructions, upon execution by the processor, enable the mobile telecommunications device to detect the proximity of the mobile telecommunications device to the vehicle.

237. In the combination discussed in Section XVI.A, a POSITA would have configured Bluetooth communication device 188 of device 100 to detect proximity of a vehicle (“***detect the proximity of the mobile telecommunications device to the vehicle***”) (as taught in Willis). USAA-1009, 1:23-27, 14:25-15:3.

XVII.[GROUND 1G] – FORSTALL, RABU, LANGLE2009, WARREN, AND BERKOBIN RENDERS CLAIM 55 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren-Berkobin Combination

238. Using artificial intelligence to evaluate driver information well-known by the Critical Date. USAA-1010, [0031]; USAA-1025, [0047]; USAA-1014, [0094]. A POSITA would have been motivated to employ artificial intelligence to identify unsafe driving behaviors from motion data recorded for a vehicle for the reasons discussed in Section XVII.A (incorporated here by reference).

239. A POSITA would have perceived the benefit of increasing accuracy of identifying unsafe driving behaviors since Langle2009 expresses a desire to “enhance and strengthen [the world’s] emergency services[.]” through the use of mobile devices to “aid in safe driving practices and detection of emergencies.” USAA-1029, Abstract. A POSITA would have looked to techniques for improving accuracy in driver safety monitoring, and in doing so, identified artificial intelligence as an available tool to process sensor data collected by device 100 in identifying unsafe driving behaviors. A POSITA would also have had a reasonable expectation of success in implementing the combination because similar configurations were well-known by the Critical Date.

B. Analysis

240. The Forstall-Rabu-Langle2009-Warren-Berkobin combination (*see* Section XVII.A) renders this claim obvious the following limitations of claim 55 in

the same manner as explained above for the corresponding claim 54 limitations listed in the table below.

Claim 54 Limitation	Corresponding Limitations
[54.1]	[55.1]
[54.2]	[55.2]
[54.3]	[55.3]
[54.4]	[55.4]
[54.5]	[55.5]
[54.6]	[55.6]
[54.7]	[55.7]
[54.8]	[55.9]
[54.9]	[55.10]
[54.10]	[55.11]

1. *Claim 55*

[55.8] the processing involving the use of a neural network on the mobile telecommunications device to determine whether the driving information represents an acceptable or unacceptable driving pattern; and,

241. The term “neural network” appears once in the ’879 patent specification and relevant disclosure closely repeats the language recited by this claim limitation. USAA-1001, 6:61-7:3 (“use of virtual neural networks can be used to determine whether the driving information represents acceptable or unacceptable driving patterns”). Beyond these general descriptions, ’879 patent specification lacks any discernible disclosure relating to which types of specific

neural networks are used to evaluate sensor data to identify acceptable or unacceptable driving patterns.

242. Berkobin describes using a neural network to process sensor data and evaluate driving information (“***processing involving the use of a neural network***”). USAA-1010, [0002], [0031]. In the Forstall-Rabu-Langle2009-Warren-Berkobin (see Section XVII.A), a POSITA would have configured device 100 to use a neural network to evaluate driving safety data (e.g., acceleration, braking) determine whether it indicates a safe driving behavior (e.g., safe acceleration, safe braking) (“***an acceptable [driving pattern]***”) or an unsafe driving behavior (e.g., unsafe acceleration, unsafe braking) (“***unacceptable driving behavior***”). USAA-1029, 502-504.

XVIII. CONCLUSION

243. The findings and opinions set forth in this declaration are based on my work and examinations to date.

244. I may continue my examinations. I may also receive additional documentation and other factual evidence over the course of this IPR that will allow me to supplement and/or refine my opinions. I reserve the right to add to, alter, or delete my opinions and my declaration upon discovery of any additional information. I reserve the right to make such changes as may be deemed necessary.

245. In signing this declaration, I recognize that the declaration will be filed as evidence in an IPR before the PTAB. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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

APPENDIX A

Curriculum Vitae for William R. Michalson

Research Associates, LLC
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1. Personal:

1.1 Education

Ph.D. in Electrical Engineering, 1989, Worcester Polytechnic Institute, Worcester, Massachusetts.

Dissertation: *A Parallel Computer Architecture for Real-Time Decision Making*. The dissertation develops a hierarchical, multiple processor, computer architecture for executing artificial intelligence programs in real-time. Dissertation Directors: Dr. Peter E. Green and Dr. R. James Duckworth.

Minor Areas: Minor sequences completed in Mathematics and Physics.

Specialties: Area examinations passed in the fields of Computer Architecture, Probabilistic Systems Analysis, and State Space Analysis.

M.S. in Electrical Engineering, 1985, Worcester Polytechnic Institute, Worcester, Massachusetts.

Specialties: The courses taken stressed Computer Architecture, Communications Systems, and Solid-State Physics.

B.S. in Electrical Engineering, 1981, Syracuse University, Syracuse, New York.

1.2 Work experiences - Academic.

1991-Present Worcester Polytechnic Institute

Professor of Electrical and Computer Engineering; also holds collaborative appointments as a Professor of Computer Science, a Professor of Mechanical Engineering and a Professor of Robotics Engineering.

Effective Sep, 2016 Granted a collaborative appointment as a Professor of Mechanical Engineering.

Effective July 1, 2005 Promoted to the rank of Full Professor (Professor of Electrical and Professor of Computer Science)

<i>November 17, 2004</i>	Appointed dual professorship, adding the title of Associate Professor of Computer Science.
<i>July 1, 1998</i>	Granted tenure and promoted to the rank of Associate Professor.
<i>August 1, 1992</i>	Assistant Professor of Electrical Engineering (tenure-track).
<i>August 1, 1991</i>	Visiting Assistant Professor of Electrical Engineering.
<i>January 1, 1990</i>	Adjunct Assistant Professor of Electrical Engineering.

1.3 Work experiences other than teaching (chronological).

2012-2014 Grid Roots, LLC

Grid Roots, LLC is a company which was formed in 2012 for the purpose of commercializing a navigation and tracking device for use by children and the elderly to allow caregivers to non-intrusively monitor their activities. The system under development integrates GPS, inertial and beacon-based navigation technologies to develop a system for users to track deployed devices. My responsibilities within Grid Roots, LLC relate to hardware and software engineering, as well as the development of IP related to tracking individuals.

1995-Present Research Associates, LLC

Research Associates, LLC is a company I formed in which I perform engineering and consulting in the areas of computer systems, communications and navigation. All of my litigation-related and other consulting activities are performed through Research Associates, LLC.

1988-1991 Raytheon Company

Subsequent to receiving my Ph. D., I returned to the Equipment Division of the Raytheon Company. Shortly after I returned, I was promoted to a title of Engineer, Design and Development which was the highest title I could hold based on my level of education and years of experience. Within a year, I was selected to sit on the engineering staff of a newly formed System Engineering Department of the Division's Computer and Displays Laboratory. In this department I acted primarily as a consultant to other departments within the laboratory. My responsibilities ranged from leading the hardware/software development of supercomputer-class computer systems to performing applied research into the exploitation of new technology. My role was similar to that of a Principle Investigator in an academic setting as I was responsible for securing funding and personnel, leading research efforts, interacting with the research sponsor, and reporting results. At the time of my departure I was involved with the following projects:

Fault-Tolerant Multiprocessor

The development of a highly fault tolerant, highly reliable, real-time computer system intended for long-duration spaceborne applications. This system is designed to produce in excess of one gigaoperation per second of raw processing power.

Optimal Task Allocation

A program of applied research into the use of Genetic Algorithms for deriving optimal mappings of software tasks to the hardware processing elements in distributed systems.

Performance Modeling and Scaling

This project focused on the development of simulation models for characterizing the performance of a large scale multiple processor system. These models formed a basis for predicting system performance for several different hardware configurations to ensure compliance with system specifications.

High Clutter Signal Detection

A program of applied research into the use of Neural Networks to detect the presence of targets in extremely high clutter environments.

Power Efficient Computing

A program of applied research into an Integrated Optical computer structure that is designed to maximize the number of computations that can be performed per unit of power.

1985-1988 Raytheon Company (Leave of Absence)

In 1985 I became one of two people in the Equipment Division to receive Aldo Miccioli Fellowships. This Fellowship was awarded to allow me to pursue full-time study towards the Ph.D. degree. I returned to Raytheon during the summer of 1986, but otherwise remained on leave of absence to dedicate my time to my studies.

1982-1985 Raytheon Company

Engineer in the VLSI Design Department of the Computer and Displays Laboratory within Raytheon's Equipment Division. I was lead engineer for the design of several semi-custom VLSI circuits for both signal and data processing applications.

1981-1982 Raytheon Company

Engineer in the Cursive Displays Department of the Computer and Displays Laboratory. I designed and debugged circuit assemblies which were used in vector displays for air traffic control applications.

1.4 Consulting experiences.

1.4.1 Law-Related

Volvo Penta of the Americas, LLC. v. Brunswick Corporation

Retained by Kilpatrick Townsend & Stockton, LLP as an expert on behalf of petitioner Volvo Penta. Provided declarations in support of multiple IPR filings (IPR2022-01366, IPR2022-01367, IPR2022-01368, IPR2022-01369, and IPR2022-01424). Retained 6/22.

Textron Innovations INC. v. SZ DJI Technology Co, LTD. and DJI Europe B.V.

Retained by Baker Botts, LLP as an expert on behalf of plaintiff Textron. Retained 2/22, deposed 1/22/23 and 1/24/23.

Smartsky Networks, LLC, v. GOGO Business Aviation, LLC and GOGO INC.

Retained by Sidley Austin, LLP as an expert on behalf of defendant Gogo. Case before the United States District Court for the District of Delaware (Case No. 22-266 UNA). Deposed 5/19/22. Retained 3/22.

Via Transportation, Inc. v. RideCo Inc.

Retained by Erise, IP on behalf of defendant RideCo. Case before the United States District Court for the Western District of Texas, (Case No. No. 6:21-cv-00457). Retained 1/22.

BillJCo, LLC v. Cisco Systems, Inc., Apple Inc., Hewlett Packard Enterprise Co. and Aruba Networks, LLC

Retained by the law firms of Merchant & Gould, P.C., DLA Piper, and Greenberg Traurig, LLP Purpose on behalf of their clients Cisco Systems, Inc., Apple Inc., Hewlett Packard Enterprise Co. and Aruba Networks, LLC for the analysis of certain patents relating to methods and systems for location tracking of mobile devices. Submitted declaration related to IPR2022-420 and IPR2022-00427. Retained 12/21.

Mark Adams, Sr., v. Cataldo Ambulance Service, Inc,

Retained by Morrisson Mahoney, LLP on behalf of defendant Cataldo Ambulance Service. Case before Middlesex Superior Court, Commonwealth of Massachusetts, Civil Action No. 19-CV-1931. Retained 10/21.

LoganTree, LP v. Garmin International, Inc. and Garmin USA, Inc.

Retained by EriselP on behalf of defendant Garmin. Case before the District of Kansas, Case No. 17-cv-01217 2:16-cv-190 involving U.S. Patent No. 6,059,576. Submitted Expert Report on Non-Infringement; Deposed 12/1/21; testified in Court 10/26/22; Retained 7/21 - 10/22.

Allstate Insurance Company V. Atos, LLC

Retained by Sidley Austin, LLP on behalf of petitioner Allstate Insurance Company challenging the validity of US Patent Nos. 8,527,140; 9,152,609; and 9,846,174 at the Patent Trial and Appeal Board of the U.S. Patent Office. Submitted declarations in IPR2021-01118, IPR2021-01209, and IPR2021-01449. Deposed 3/31/22 and 4/7/22; Retained 2/21.

R&R Packaging, Inc. D/B/A R&R Solutions v. Evenflo Company, Inc.

Retained by Polsinelli on behalf of Plaintiff R&R. Case before the Western District of Arkansas (Fayettevill Division), Case No. 5-20-cv-05095. Submitted Reports on Claim Construction; Deposed 7/21; Retained 11/20.

InfoGation Corporation v. Google LLC.

Retained by O'Melveny & Meyers, LLP as an expert on behalf of defendant Google Inc. Patents-in-suit are U.S. Patents 6,199,014. Case before the United States District Court for the

Southern District of California, San Diego Division (Case No. 3:21-CV-00843-H-JLB).
Deposed 2/27/13 - 2/28/13. Retained 8/20 to 6/22.

WSOU Investments LLC v. Dell Technologies Inc. et al.

Retained by Gibson-Dunn on behalf of defendant Dell. Case before the United States District Court for the Western District of Texas, (Case Nos. 20-cv-00473-ADA; 20-cv-00474-ADA; 20-cv-00475-ADA; 20-cv-00476-ADA; 20-cv-00477-ADA; 20-cv-00478-ADA; 20-cv-00479-ADA; 20-cv-00482-ADA). Retained 7/20.

Apple v. LBS Innovations, LLC.

Retained by Ericson on behalf of petitioner Apple, Inc., challenging the validity of U.S. Patent No. 6,091,956 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2020-00696. Retained 02/20. Submitted declaration.

Makor Issues & Rights Ltd. v. Google LLC et al.

Retained by Arnold & Porter Kaye Scholer LLP on behalf of defendant Google. Case before the District of Delaware, Case No. 1:16-cv-00100. Retained 12/19.

Intellectual Ventures I, LLC and Intellectual Ventures II, LLC v. NetApp, Inc.

Retained by Gibson Dunn on behalf of defendant NetApp, Inc. Case before the District of Massachusetts, Case No. 1:16-cv-10868-PBS. Retained 09/19. Submitted Expert Reports on Invalidity and Non-Infringement.

Google, LLC v. Traxcell Technologies, LLC.

Retained by Finnegan, Henderson, Farabow, Garrett & Dunner, LLP on behalf of petitioner Google, Inc., challenging the validity of U.S. Patent Nos. 9,918,196 and 10,820,147 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2021-01004 and IPR2022-00442. Retained 06/18. Submitted declarations.

Lipton, et al. v. Knight, et al.

Retained by Campbell Conroy & O'Neil, PC on behalf of defendant First Student. Case before the Superior Court of Massachusetts, Plymouth, Case No. PLCV 2014-00528. Retained 05/19-8/19. Submitted Expert Disclosure.

PPS Data, LLC., v. Jack Henry & Associates, Inc.

Retained by Polsinelli on behalf of defendant Jack Henry and Associates. Case before the Eastern District of Texas. Retained 11/18-9/19. Submitted Expert Reports on Invalidity and Non-Infringement; Deposed 5/29/19, testified in Court 9/11/19.

Cisco Systems, Inc. v. TracBeam, LLC.

Retained by Haynes Boone, LLP on behalf of petitioner Google, Inc., challenging the validity of U.S. Patent Nos. 7,525,484 9,277,525, and 7,298,327 at the Patent Trial and Appeal Board of the U.S. Patent Office, IPR2018-01722 - IPR2018-01728. Retained 06/18. Submitted declarations.

Burris Company, Inc. v. Garmin International, Inc.

Retained by Shook Hardy and Bacon on behalf of defendant Garmin. Case before the District of Oregon, Case No. 6:18-CV-00700. Submitted Declaration wrt Invalidity; Testified in Court (PI hearing) 07/11/18; Retained 04/18-08/18.

American GNC Corporation v. LG Electronics Inc., LG Electronics Mobilecomm U.S.A., Inc., and LG Electronics Mobile Research U.S.A., LLC.

Retained by White & Case on behalf of defendant LG. Case before the Southern District of California, Case No. 3:17-CV-01090-BAS-BLM. Retained 11/17. Submitted Declaration wrt Claim Construction; Deposed 1/18.

Qualcomm v. Apple

Retained by Quinn-Emanuel on behalf of plaintiff Qualcomm. Case before the Southern District of California, Case Nos. 3:17-cv-00108-GPC-MDD and 3:17-cv-01010-GPC-MDD. Retained 10/17-5/19; Submitted Expert Report; Deposed 10/18.

Samantha Ingram v. New England Beauty Academy, LLC a/k/a Toni&Guy Hairdressing Academy, Newell Rubbermaid INC. and Goody Products, INC. d/b/a Solano.

Retained on behalf of plaintiff Samantha Ingram. Case before the Worcester Superior Court, Commonwealth of Massachusetts, Civil Action 1385CV02129D. Retained 09/17-09/18; Submitted Expert Disclosure.

FISERV, INC., Jack Henry & Associates, Inc., Q2 Software, Inc., American National Bank of Texas and Hanmi Bank, Petitioners v. Mirror Imaging LLC., Patent Owner.

Retained by Polsinelli on behalf of petitioners to provide declarations for multiple petitions for covered business methods review. See CBM2018-00012, CBM2018-00014, and CBM2018-00015. Retained 1/18-03/18.

Acceleron v. Dell Inc.

Retained by Baker Botts on behalf of defendant Dell. Case before the Northern District of Georgia, Case No. 1:12-cv-04123-TCB. Submitted Expert Reports related to Claim Construction, Invalidity and Non-Infringement; Deposed 10/13/17 and 6/20/19; Trial 9/6/21 to 9/17/21; Retained 7/17 to 9/21.

Omega Patents, LLC v. CalAmp Corp.

Retained by Sidley Austin on behalf of defendant CalAmp. Case before the Middle District of Florida, Case No. 6:13-cv-1950 involving U.S. Patent Nos. 6,346,876; 6,756,885; 7,671,727 and 8,032,278. Retained 5/17 to 12/17.

Unified Patents, Inc.

Retained by Unified Patents to provide declarations for multiple petitions for *inter partes* review related to patents U.S. Patent No. 7,650,234 and 8,538,498. Retained 03/17-05/17.

Garmin Switzerland GmbH, and Garmin Corporation v. Navico Inc., C-MAP USA, Inc., and C-MAP/Commercial, Ltd.

Retained by Shook, Hardy & Bacon, L.L.P. on behalf of plaintiff Garmin. Case before the District of Kansas, Case No. 16-cv-2706 involving U.S. Patent Nos. 7,268,703 and 6,459,987. Submitted Declaration On Claim Construction; Deposed 12/21/17; Retained 10/16 to 02/18.

Navico Inc. and Navico Holdings AS, v. Garmin International, Inc. and Garmin USA, Inc.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Eastern District of Texas, Case No. 2:16-cv-190 involving U.S. Patent Nos. 9,223,922 and 9,244,168. Submitted Expert Report on Non-Infringement; Deposed 12/14/16, 5/25/17; Testified in Court 9/7/17; Retained 8/16 to 9/17.

Orbcomm, Inc. v. CalAmp Corp.

Retained by Sidley Austin on behalf of defendant CalAmp. Case before the Eastern District of Virginia, Case No. 3:16-cv-208 involving U.S. Patent Nos. 6,292,724, 6,611,686, 6,651,001, 6,735,150, and 8,855,626. Expert Declaration on Claim Construction, Reports on Invalidity and Non-Infringement; Retained 5/16 to 2/17.

Navico Inc. and Navico Holdings AS, v. Garmin International, Inc. and Garmin USA, Inc.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Northern District of Oklahoma, Case No. 14-cv-303 involving U.S. Patent Nos. 8,300,499, 8,305,840, and 8,605,550. Deposed 11/8/15; Retained 10/15 to 10/17.

Johnson Outdoors Inc. and Johnson Outdoors Marine Electronics, Inc., v. Garmin International, Inc. and Garmin USA.

Retained by Paul Weiss on behalf of defendant Garmin. Case before the Middle District of Alabama, Case No. 14-cv-683 involving U.S. Patent Nos. 7,652,952, 7,710,825, and 7,755,974. Retained 10/15 to 5/16. Case dismissed.

Google, Inc. v. Silver State Intellectual Technologies, Inc.

Retained by Paul Hastings on behalf of petitioner Google, Inc. to provide declarations for multiple petitions for *inter partes* review. See IPR2015-01737 and IPR2015-01738. Retained 10/15 to 12/15.

Vehicle IP LLC v. AT&T Mobility, LLC, et al.

Retained by Akin Gump and by Perkins-Coie on behalf of defendants AT&T Mobility LLC; Cellco Partnership; Networks In Motion, Inc.; TeleCommunications Systems, Inc.; and Telenav Inc. Case before the District of Delaware, Case No. 1:09-cv-01007-LPS involving U.S. Patent No. 5,987,377. Expert Report on Invalidity; Deposed 5/20/16; Retained 9/15 to 1/17. Matter settled.

TracBeam, L.L.C. v. T-Mobile US, Inc., et al.,

Retained by Baker Botts on behalf of defendant T-Mobile US, Inc., et al. Case before the Eastern District of Texas (6:14-cv-678-RWS). See also IPR2015-01681, IPR2015-01682, IPR2015-01684, IPR2015-01686, IPR2015-01687, IPR2015-01708, IPR2015-01709, IPR2015-01711, IPR2015-01712, and IPR2015-01713. Expert Report on Invalidity; Deposed 10/04/16; Retained 7/15 to 12/16. Matter settled.

Google, Inc. v. Porto Technology Co., Ltd.

Retained by Fish and Richardson on behalf of petitioner Google, Inc., patent owner Porto Technology Inc. IPR2016-00022 and IPR2016-00045. Expert Declarations; Deposed: 7/14/16 (IPR2016-00022); 7/14/16 (IPR2016-00045). Retained 7/15 to 7/20.

Bradium Technologies LLC v. Microsoft Corporation,

Retained by Perkins Coie on behalf of defendant Microsoft Corporation. Case before the District of Delaware (15-0031-RGA). See also IPR2015-01432, IPR2015-01434, IPR2015-01435, IPR2016-00448 and IPR2016-00449. Expert Declarations; Deposed 8/5/16, 02/21/17; (IPR2015-01432); Retained 3/15 to 10/17.

ACQIS LLC v. EMC Corp.,

Retained by Gibson Dunn on behalf of defendant EMC Corp. Case before the District of Massachusetts (1:14-cv-13560). Expert Report on Invalidity; Retained 2/15 to 2/21.

Locata LBS LLC v. YellowPages.com LLC,

Retained by Baker Botts on behalf of defendant YellowPages.com. Case before the Central District of California (2:13-cv-07664). See also IPR2015-00151. Submitted Declaration. Retained 9/14 to 4/15. Matter settled.

M/A-COM Technology Solutions Holdings, Inc. v. Laird Technologies, Inc.

Retained by Erise IP on behalf of Laird Technologies, Inc., for invalidity consulting regarding U.S. Patent No. 6,272,349. Retained 6/14 to 9/14.

Certusview Technologies, LLC v. S&N Locating Services, LLC and S&N Communications, Inc.,

Retained by Baker & McKenzie on behalf of defendant S&N. Patents-in-suit are U.S. Patents 8,265,344, 8,290,204, 8,340,359, 8,407,001, and 8,532,341. Case before the Eastern District of Virginia, (2:13-cv-346). Expert Report on Non-Infringement; Deposed 11/8/14; Retained 6/14 to 12/14.

adidas AG and adidas America, Inc. v. Under Armour, Inc. and MapMyFitness, Inc.

Retained by Kilpatrick Townsend on behalf of plaintiff adidas. Case before the District of Delaware, (1:14-cv-00130). See also IPR2015-00697, IPR2015-00698, and IPR2015-00700. Deposed: 10/21/16 and 10/22/16 relative to 1:14-cv-00130; 2/5/16 relative to IPR2015-00697; 2/5/16 relative to IPR2015-0068; 2/5/16 relative to IPR2015-0700. IPR Declarations, Expert Report on Validity; Deposed 02/05/16; Retained 5/14 to 7/16.

GeoTag, Inc., v. AT&T Mobility LLC and AT&T Services, Inc.,

Retained by Baker Botts as an expert on behalf of defendant AT&T. Patent-in-suit is U.S. Patent 5,930,474. Case before the Northern District of Texas, Dallas Division, (3:13-cv-00169). Expert Report on Invalidity; Deposed 5/29/14; Retained 1/14 to 9/14. Matter settled.

Nokia Corp v. HTC Corp.

Retained by Quinn Emanuel as an expert on behalf of defendant HTC. Case being litigated in Germany. Patent number EP0766811B1. Retained 12/13 to 2/14. Matter settled.

Porto Technology, Co., Ltd. et al. v. Cellco Partnership d/b/a Verizon Wireless

Retained by Wiley-Rein as an expert on behalf of defendant Verizon. Case before the United States District Court for the Eastern District of Virginia (Case No. 3:13-cv-00265). Declaration ISO Claim Construction and Summary Judgement of Invalidity; Expert Report on Invalidity; Retained 10/13 to 2/14. Matter dismissed.

Nokia Corp v. HTC Corp.

Retained by McDermott Will and Emery and White & Case as an expert on behalf of defendant HTC. Case before the United States District Court for the District of Delaware (Case No. Case No. 1:12-cv-00550-UNA and Case No. 1:12-cv-551-UNA. Retained 6/13 to 2/14. Matter settled.

NXP B.V. v. Research In Motion, Ltd., et al.

Retained by Fish and Richardson as an expert on behalf of defendant Research In Motion. Patent-in-suit is U.S. Patent 6,501,420. Case before the United States District Court for the Middle District of Florida (Case No. 6:12-cv-00498). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 9/18/13; Testified in Court: 4/1/14 and 4/2/14; Retained 5/13 to 4/14.

Vehicle IP LLC v. Wal-Mart Stores Inc., et al.

Retained by Polsinelli-Shugart, as an expert on behalf of defendant Werner Enterprises. Patent-in-suit is U.S. Patent 5,694,322. Case before the United States District Court for the District of Delaware (Case No. 1:10-cv-00503). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 7/15/13 and 9/20/13; Testified in Court: 9/27/13 and 9/30/13; Retained 4/13 to 9/13.

Commonwealth Scientific and Industrial Research Organisation v. Realtek Semiconductor Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Realtek Semiconductor Corporation. Patent-in-suit is U.S. Patent 5,487,069. Case before the United States District Court for the Eastern District of Texas (Tyler Division) (Case No. 6:12-cv-00578). Expert Report on Invalidity, Expert Report on Non-Infringement; Deposed 3/6/15; Retained 4/13 to 4/15. Matter settled.

TracBeam, LLC v. Google Inc.

Retained by Quinn-Emanuel as an expert on behalf of defendant Google. Patents-in-suit are U.S. Patents 7,764,231 and 7,525,484. Case before the United States District Court for the Eastern District of Texas (6:11-cv-00093). Deposed 2/5/14; Retained 3/13 to 6/14.

Microsoft Corporation and Google Inc., v. GeoTag, Inc.

Retained by Perkins-Coie as an expert on behalf of plaintiff Microsoft Corporation. Patent-in-suit is U.S. Patents 5,930,474. Case before the United States District Court for the District of Delaware (1:11-cv-00175). Retained 1/13 to 9/14.

GeoTag, Inc., v. Frontier Communications Corp., et al.,

Retained by multiple firms as an expert on behalf of defendants. Patent-in-suit is U.S. Patents 5,930,474. Case before the Eastern District of Texas, Marshall Division, (2:10-cv-00265; other defendants are listed in case numbers 2:10-cv-00265, 2:10-cv-00272, 2:10-cv-00437, 2:10-cv-00569, 2:10-cv-00570, 2:10-cv-00571, 2:10-cv-00572, 2:10-cv-00573, 2:10-cv-00574, 2:10-cv-00575, 2:10-cv-00587, 2:11-cv-00175, 2:11-cv-00404, 2:11-cv-00421, 2:11-cv-00424, 2:11-cv-00425, 2:11-cv-00570, 2:12-cv-00043, 2:12-cv-00051, 2:12-cv-00436, 2:12-cv-00438, 2:12-cv-

00439, 2:12-cv-00441, 2:12-cv-00442, 2:12-cv-00444, 2:12-cv-00445, 2:12-cv-00446, 2:12-cv-00447, 2:12-cv-00448, 2:12-cv-00449, 2:12-cv-00450, 2:12-cv-00452, 2:12-cv-00454, 2:12-cv-00456, 2:12-cv-00459, 2:12-cv-00460, 2:12-cv-00462, 2:12-cv-00464, 2:12-cv-00466, 2:12-cv-00468, 2:12-cv-00469, 2:12-cv-00470, 2:12-cv-00471, 2:12-cv-00473, 2:12-cv-00474, 2:12-cv-00475, 2:12-cv-00476, 2:12-cv-00476, 2:12-cv-00477, 2:12-cv-00480, 2:12-cv-00481, 2:12-cv-00482, 2:12-cv-00482, 2:12-cv-00483, 2:12-cv-00486, 2:12-cv-00487, 2:12-cv-00520, 2:12-cv-00521, 2:12-cv-00523, 2:12-cv-00524, 2:12-cv-00525, 2:12-cv-00527, 2:12-cv-00528, 2:12-cv-00530, 2:12-cv-00532, 2:12-cv-00534, 2:12-cv-00535, 2:12-cv-00536, 2:12-cv-00537, 2:12-cv-00542, 2:12-cv-00543, 2:12-cv-00545, 2:12-cv-00547, 2:12-cv-00548, 2:12-cv-00549, 2:12-cv-00550, 2:12-cv-00551, 2:12-cv-00552, 2:12-cv-00555, 2:12-cv-00556, 2:12-cv-00570, 2:12-cv-00572, 2:12-cv-00573, 2:12-cv-00575, 2:12-cv-00587, 3:13-cv-00217). Deposed 5/29/14; Retained 1/13 to 9/14.

MOSAID Technologies Inc., v. Realtek Semiconductor Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Realtek Semiconductor Corporation. Patents-in-suit are U.S. Patents 5,131,006; 5,151,920; 5,422,887; 5,706,428; 6,563,786; and 6,992,972. Case before the United States District Court for the Eastern District of Texas (Tyler Division) (Case No. 2:11-cv-00179). Retained 12/12 to 12/12. Matter settled.

Hoyt A. Flemming v. Cobra Electronics Corporation

Retained by Sidley Austin, LLP as an expert on behalf of defendant Cobra Electronics Corporation. Patents-in-suit are U.S. Patents RE39038, RE40653 and RE41905. Case before the United States District Court for the District of Idaho (Case No. 1:12-cv-00392). Retained 11/12 to 06/13. Matter settled.

LBS Innovations LLC v. Aaron Bros., Inc., et al.

Retained as an expert on behalf of defendants Whole Foods Marketplace, Comerica, Hotels.com, Academy, Ltd., and Homestyle Dining. Patent-in-suit is U.S. Patent 6,091,956. Case before the Eastern District of Texas, Marshall Division, (Case No. 2:11-cv-00142-MHS-CMC. Deposed 10/5/12; Retained 7/12 to 12/12. Plaintiff moved to dismiss.

Advanced Media Networks, L.L.C. v. Gogo LLC et al.

Retained by Sidley Austin, LLP as an expert on behalf of defendant Gogo. Patent-in-suit is U.S. Patent 5,960,074. Case before the United States District Court for the Central District of California (Case No. 11-cv-10474). Deposed 2/6/13. Retained 7/12 to 8/13.

Walker Digital, LLC v. Google Inc.

Retained by O'Melveny & Meyers, LLP as an expert on behalf of defendant Google Inc. Patents-in-suit are U.S. Patents 6,199,014. Case before the United States District Court for the District of Delaware (Case No. 1:11-cv-00309-SLR). Deposed 2/27/13 - 2/28/13. Retained 6/12 to 8/13.

Silver State Intellectual Technologies, Inc. v. Garmin International, Inc., et al.

Retained by Erise IP, P.A. as an expert on behalf of defendants Garmin International, Inc. and Garmin USA, Inc. Patents-in-suit are U.S. Patents 6,525,768; 6,529,824; 6,542,812; 7,343,165; 7,522,992; 7,593,812; 7,650,234; 7,702,455 and 7,739,039. Case before the United States

District Court for the District of Nevada (Case No. 2:11-cv-1578). Deposed 2/19/14; Testified in Court: 5/21/15; Retained 4/12 to 5/15.

Beacon Navigation GmbH v. Toyota Motor Corporation, et al.

Retained by Kirkland & Ellis, LLP on behalf of defendants Toyota Motor Corporation; Toyota Motor North America, Inc.; Toyota Motor Sales, U.S.A. Inc.; Toyota Motor Engineering & Manufacturing North America, Inc.; Toyota Motor Manufacturing, Indiana, Inc.; Toyota Motor Manufacturing, Kentucky, Inc.; Toyota Motor Manufacturing Mississippi, Inc.; Mazda Motor Corporation; Mazda Motor of America, Inc.; Fuji Heavy Industries, Ltd.; Fuji Heavy Industries U.S.A. Inc.; Subaru of America, Inc.; Jaguar Land Rover North America, LLC; Jaguar Cars Limited; Land Rover; Volvo Car Corporation; and Volvo Cars of North America, LLC; Adduci Mastriani & Schaumberg, LLP on behalf of defendants Suzuki and Garmin; Crowell-Moring on behalf of General Motors; Dickstein Shapiro on behalf of Chrysler Group, LLC; Finnegan, Henderson, Farabow, Garrett & Dunner on behalf of Bayerische Motoren Werke AG, BMW of North America, LLC, and BMW Manufacturing Co. LLC; Fish & Richardson on behalf of Honda Motor Co., Ltd., Honda North America, Inc., American Honda Motor Co., Inc., Honda Manufacturing of Alabama, LLC, Honda Manufacturing of Indiana, LLC, and Honda of America, Mfg., Inc.; Frommer Lawrence and Haug, LLP on behalf of Dr. Ing. h.c.F. Porsche AG and Porsche Cars North America, Inc.; Hogan Lovells on behalf of Daimler AG, Mercedes-Benz USA, LLC, or Mercedes-Benz U.S. International, Inc.; Quinn-Emanuel on behalf of Nissan and Ford. Case before the US International Trade Commission, Washington D.C., in the matter of: “Certain Automotive Navigation Systems, Components Thereof, and Products Containing Same, Inv. No. 337-TA-814. Case withdrawn by Plaintiff. Retained 1/12 – 4/12.

Beacon Navigation GmbH v. Toyota Motor Corporation, et al.

Retained by Kirkland & Ellis, LLP on behalf of defendants Toyota Motor Corporation; Toyota Motor North America, Inc.; Toyota Motor Sales, U.S.A. Inc.; Toyota Motor Engineering & Manufacturing North America, Inc.; Toyota Motor Manufacturing, Indiana, Inc.; Toyota Motor Manufacturing, Kentucky, Inc.; Toyota Motor Manufacturing Mississippi, Inc.; Mazda Motor Corporation; Mazda Motor of America, Inc.; Fuji Heavy Industries, Ltd.; Fuji Heavy Industries U.S.A. Inc.; Subaru of America, Inc.; Jaguar Land Rover North America, LLC; Jaguar Cars Limited; Land Rover; Volvo Car Corporation; and Volvo Cars of North America, LLC. Multiple cases before the United States District Court for the District of Delaware. Case numbers 1:11-cv-00942-UNA, 1:11-cv-00941-UNA, 1:11-cv-00951-UNA, 1:11-cv-00952-UNA, 1:11-cv-00936-UNA, 1:11-cv-00937-UNA, 1:11-cv-00955-UNA, 1:11-cv-00959-UNA, and 1:11-cv-00960-UNA. Currently stayed. Retained 1/12.

Beacon Wireless Solutions, Inc., et al., v. Garmin International, Inc., et al.

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of defendant Garmin. Matter involves alleged trade secret misappropriation. Case before the United States District Court for the Western District of Virginia, Harrisonburg Division (Case No. 5:11-cv-00025). Testified in Court: 5/25/12. Retained 12/11 to 5/25/12.

Tramontane IP, LLC v. Garmin Int’l, Inc., et al.

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of defendant Garmin. Patents-in-suit are U.S. Patents 6,526,268 and 7,133,775. Case before the United States District Court for the Eastern District of Virginia (Case No. 1:2011-cv-00918). Case Settled. Retained 11/11 to 12/11.

Sourceprose, Inc. v. AT&T, Inc., MetroPCS Communications, Inc., et al.

Retained by Kilpatrick Townsend as an expert on behalf of defendant AT&T. Patents-in-suit are US Patent Nos. 7,142,217 and 7,161,604. Case before the United States District Court for the Western District of Texas, Austin Division. Case number 1:11-cv-00117. Retained 11/11 to 3/16.

Furuno Electric Co., Ltd. and Furuno U.S.A., Inc. v. Honeywell International, Inc.

Retained by Quinn-Emanuel as an expert on behalf of complainant Furuno. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain GPS Navigation Products, Components Thereof, and Related Software," Investigation number 337-TA-810. Patents-in-suit are U.S. Patent Nos. 6,084,565; 7,095,367; 7,089,094; and 7,161,561. Case settled. Retained 8/11 – 12/11.

Honeywell International, Inc. v. Furuno Electric Co., Ltd. and Furuno U.S.A., Inc.

Retained by Quinn-Emanuel as an expert on behalf of respondent Furuno. Case before the US International Trade Commission, Washington D.C., in the matter of: "Certain GPS Navigation Products, Components Thereof, and Related Software," Investigation number 337-TA-783. Patents-in-suit are U.S. Patent Nos. 7,209,070; 6,865,452; 5,461,388; and 6,088,653. Case Settled. Retained 8/11 – 12/11.

Triangle Software, Inc. v. Garmin International, Inc.

Retained by Weil, Gotshal & Manges, LLP., as an expert on behalf of defendant Garmin. Patents-in-suit are US Patents 7,557,730, 7,221,287, 7,375,649, 7,508,321 and 7,702,452. Case before the United States District Court, Eastern District of Virginia, Case No. 1:10-cv-1457 CMH/TCB. Deposed 7/28/11; Testified in Court: 11/3/11 (jury trial). Retained 4/11 to 11/11.

Garmin International, Inc. v. Pioneer Corporation and Pioneer Electronics (USA), Inc.

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of plaintiff Garmin. Patents-in-suit are U.S. Patents 5,365,448; 5,424,951; and 6,122,592. Case before the United States District Court for the District of Kansas. Case No. 10-CV-2080 JWL/GLR. Declarative Judgment action stayed. Retained 3/11 to 11/11.

Visteon Global Technologies, Inc. And Visteon Technologies, LLC v. Garmin International, Inc.

Retained by Shook, Hardy and Bacon as an expert on behalf of defendant Garmin. Patents-in-suit are US Patents 5,544,060, 5,654,892, 5,832,408, 5,987,375 and 6,097,316. Case before the United States District Court, Eastern District of Michigan, Case No. 2:10-cv-10578--PDB-MAR. Deposed 10/9/12; Retained 12/10 to 10/17.

Thomson Licensing SAS and Thomson Licensing, LLC. v. Realtek Semiconductor Corporation

Retained by Sidley-Austin as an expert on behalf of respondent Realtek Semiconductor. Case before the US International Trade Commission, Washington D.C., in the matter of: “Certain Liquid Crystal Display Devices, Including Monitors, Televisions, Modules, And Components Thereof,” Investigation number 337-TA-741. Patent-in-suit is US Patent 6,121,941. Deposed 6/29/11; Testified in Court: 9/15/11 and 9/16/11. Retained 11/10 – 9/11.

Ambato Media, LLC. v. Clarion Co., LTD., et al.

Retained by Traurig-Greenberg as an expert on behalf of defendant Garmin. Patent-in-suit is US Patent 5,432,542. Case before the United States District Court for the Eastern District Of Texas, Marshall Division. Case number 2:09-CV-242. Deposed 4/26/12 and 5/10/12; Testified in Court: 7/11/12. Retained 10/10 to 7/12.

Gabriel Technologies Corporation and Trace Technologies, LLC, v. Qualcomm Incorporated, Snaptrack, Inc. and Norman Krasner

Retained by Cooley-Godward as an expert on behalf of defendants Qualcomm, Snaptrack, and Krasner. Trade secret misappropriation case related to US Patents 6,377,209, 6,583,757, 6,661,372, 6,799,050, 6,861,980, 6,895,249, 7,254,402, 7,289,786, 7,319,876, 7,421,277, 7,446,655, 7,570,958, 7,574,195, and 7,660,588. Case before the Southern District of California San Diego Division, Case No. 08-cv-1992 MMA POR. Retained 6/10 to 7/12.

SiRF/CSR v. Global Locate/Broadcom Corporation

Retained by Wilmer-Hale as an expert on behalf of defendant Global Locate / Broadcom. Patents-in-suit are US Patents 5,663,735, 6,480,150, 6,519,466, 6,650,879, 6,882,827, 6,934,322, 7,412,157, 7,236,883, and 7,573,422. Case before the Central District of California, Case No. 8:06-cv-01216 and Case No. 8:10-cv-01281. Retained 9/10 to 1/11.

Pioneer Electronics v. Garmin Corporation

Retained by Shook, Hardy and Bacon, LLP as an expert on behalf of respondent Garmin In the matter of Certain Multimedia Display and Navigation Devices and Systems, Components Thereof, and Products Containing Same; Inv. No. 337-TA-694. Patents-in-suit are U.S. Patents 5,365,448; 5,424,951; and 6,122,592. Case before the U.S. International Trade Commission. Deposed on 7/29/10; Testified at technology tutorial (8/27/10) and in the evidentiary hearing (9/20/10). Retained 4/10 to 9/10.

EMSAT Advanced Geo-Location Technology, LLC and Location Based Services LLC, v. AT&T Mobility, LLC

Retained by Baker-Botts as an expert on behalf of defendant AT&T Mobility, LLC. Patents-in-suit are U.S. Patents 7,289,763; 5,946,611; 6,324,404; and 6,847,822. Case before the U.S. District Court for the Northern District of Ohio, Eastern Division, Civil Action No. 4:08 CV 822. Deposed 5/4/10; Testified in Court: 5/10/10 (Markman hearing). Retained 12/09 to 3/11.

Tendler Cellular of Texas, LLC v. AT&T Mobility, LLC, et al.

Retained by Baker-Botts as an expert on behalf of defendants AT&T Mobility, LLC, et al. Patents-in-suit are U.S. Patents 7,447,508; 7,305,243; 7,050,818; and 6,519,463. Case before the U.S. District Court for the Eastern District of Texas (Tyler), Civil Action No. 6:09-CV-00115. Retained 8/09 to 7/10.

Ambit Corporation v. Delta Air Lines, Inc., and Aircell LLC.

Retained by Sidley Austin, LLP., as an expert on behalf of defendants Delta Airlines, Inc., and Aircell, LLC. Patent-in-suit is US patent 7,400,858. Case before the US District Court, District of Massachusetts, Boston, Civil Action No. 1:09-CV-10217-WGY. Deposed 12/4/09; Testified in Court: 12/7/09 (evidentiary hearing), 7/10 (jury trial). Retained 8/09 to 7/10.

GPS Industries, Inc. and Optimal I.P. Holdings, L.P. v. Altex Corporation, et. al.

Retained by Hitchcock-Evert as an expert on behalf of defendants Altex Corporation, Deca International Corporation, Golflogix, Inc. and L1 Technologies. Patent-in-suit is US patent 5,364,093. Case before the US District Court, Northern District of Texas, Dallas Division, Civil Action No. 3-07-CV0831-K. Deposed 6/30/09. Retained 5/08 through 7/09.

Satellite Tracking of People, LLC v. Omnilink Systems, Inc.

Retained by DLA Piper as an expert on behalf of defendant Omnilink Systems, Inc.. Patent-in-suit is US patent RE39,909. Case before the US District Court, Eastern District of Texas, Marshall Division, Civil Action No. 2-08CV-116. 12/08 – 1/11.

SiRF Technology, Inc. v. Global Locate, Inc.

Retained by DLA Piper/WilmerHale as an expert on behalf of Global Locate. Patents-in-suit include US patents 6,304,216; 6,417,801; 6,606,346; 6,651,000; 6,704,651; 6,937,187; 7,043,363; 7,091,904; 7,132,980 and 7,158,080. Case before the US International Trade Commission, Washington D.C., in the matters of: “Certain GPS Devices and Products Containing Same,” Investigation number 337-TA-602 (Global Locate, plaintiff) and “Certain GPS Chips, Associated Software and Systems, and Products Containing Same,” Investigation number 337-TA-596 (SiRF Technologies, plaintiff). My work focused on the 7,043,363 and 7,091,904 patents in defense of Global Locate/Broadcom from June 2007 through March 2008. Deposed 1/18-1/19/08; testified at trial 3/18-3/19/08.

Intellectual Science and Technology

Retained Dykema Gossett, PLLC as a technical expert on patent infringement issues related to “suspend-to-RAM” technologies in personal computers. Pre-litigation work.

Intellectual Science and Technology, Inc., v. Sony, JVC and Panasonic

Retained Dykema Gossett, PLLC as a technical expert on patent infringement issues related to US Patent 5,748,575, US Patent 6,222,799, US Patent 6,785,198, US Patent 6,662,239 and US Patent 6,717,890. Sony Electronics Inc., case number 2:06-CV-10406, JVC Americas Corp., case number 2:06-CV-10409 and Panasonic Corporation of North America case number 2:06-CV-10412. Cases heard in United States District Court, Eastern District of Michigan, Southern Division. Expert for Intellectual Science and Technology, Inc. Dec 2006 – 2008..

Kirsch Technologies v. Xerox, Canon

Retained Dykema Gossett, PLLC as an Expert Witness on patent infringement issues related to US Patent 4,816,911, Canon case number CA 00-72775, Xerox case number CA 00-72778, cases heard in United States District Court, Eastern District of Michigan, Southern Division. Expert for Kirsch Technologies. Nov 2006 – 2008..

American Video Graphics v. ATI Technologies

Retained by Sidley, Austin, Brown & Wood, Dallas, TX as a technical expert on patent infringement issues related to US Patents 5,132,670, 5,109,520, 5,084,830, 4,761,642, 4,742,474, 4,734,690, 4,730,185 and 4,694,286. Hewlett-Packard Co., et al., defendants, case number CA 6:04-CV-379-LED and Sony Corporation of America et al., defendants, case number CA 6:04-CV-399-LED. Cases heard in United States District Court, Eastern District of Texas, Tyler Division. Expert for ATI Technologies, intervener. Jan 2005 – Sep 2005.

Microsoft v. EMC

Dewey Ballantine, LLP, Washington, D.C., as a technical expert on patent infringement issues related to US Patents 5,588,147; 5,689,700; 6,393,466; 6,424,151; 6,490,594; and 6,632,248. Wrote a declaration on behalf of Microsoft. Oct 2004 – Jan 2005.

Optimum Return v. Meier Brothers

Retained by Sidley, Austin, Brown & Wood, Dallas, TX as a technical expert on Copyright infringement allegations related to software owned by Optimum Return, LLC. Cyberkatz Consulting, Inc., Handsquare, LLC, Meier Brothers, et al., defendants, case number CA 3-03CV1064-D. Case heard in United States District Court, Northern District of Texas, Dallas Division. Expert for Meier Brothers. July 2004.

Parental Guide of Texas, Inc. v. Funai Corp., et. al.

Technical expert for defendants JVC and Panasonic in their dispute over non-infringement of US Patent number 4,605,964.

Elonex I.P. Holdings, LTD. and Elonex PLC, Phase II

Expert witness for defendants Chuntex, Acer, Tatung, Lite-On, Daewoo and Envision in their dispute with Elonex non-infringement and validity for US Patent numbers 5,389,952; 5,648,799; and 5,880,719.

Storage Computer Corporation vs. Veritas Software

Technical expert for the plaintiff in matters involving Patents US 5,257,367; US 5,893,919; and US 6,098,128.

Storage Computer Corporation vs. Seagate Technology LLC

Technical expert for the defendant in matters involving US Patent RE 34,100.

Elonex I.P. Holdings, LTD. and Elonex PLC, vs. Packard Bell et. al., CA 98-689-GMS

Expert witness for defendants ViewSonic Corp., Dell Computer Corporation, MAG Technology USA, Princeton Graphic Systems, Inc., Micron Electronics, Sony Electronics and Capetronic Computer USA in their dispute with Elonex non-infringement and validity for US Patent numbers 5,389,952; 5,648,799; and 5,880,719.

1.4.2 Engineering Consulting**Offspring Media Inc.**

Technical consultant for the development of real-time auralization algorithms for integration into a consumer electronics product. Sep 2004.

Raytheon Company, Sudbury, MA

Development of techniques and requirements for implementing a fault tolerant computer system using software implemented fault tolerance (SIFT) techniques on commercial off-the-shelf processing hardware. The resultant system is to be used for highly reliable radar data and signal processing.

TVM Techno Venture Management

Provided consulting services to assist in assessing the technical claims of a company pursuing venture capital investment for a hardware implemented RAID 5 system .

Keyhold Engineering Inc., Northboro, MA.

Development of a prototype system for automatically calibrating multiple channel audio systems.

American Navigation Systems Inc., Milbury, MA.

Consulting on the development of the hand-held personal navigation and mapping system.

Lincoln Laboratory, Bedford, MA.

Simulated, tested and evaluated a GPS integrity monitoring algorithm developed at Lincoln Laboratories.

1.5 Licenses and Certifications

1.5.1 Commercial Radio Operator

General Radiotelephone Operator License
Ship RADAR endorsement

1.5.2 Amateur Radio Operator

Amateur Extra class radio operator license.

1.5.3 Diving Certifications

PADI Open Water Diver (ISO 24801-2 Diver Level 2 – Autonomous Diver)

2. Courses Taught at WPI

2.1 Course Descriptions

Short descriptions of the courses taught are as follows:

EE572N Advanced System Architecture

This course focuses on the architectural techniques used to achieve high-performance in SISD and SIMD computer systems. In this course the interaction between the software application and hardware architecture and the effect of this interaction on achievable

performance is stressed. The course begins by covering the basic architectural tricks used to enhance system performance and ends with a series of case studies that analyze specific architectures such as the CRAY and CDC vector supercomputers, the MasPar, the Connection Machine, the ICL DAP, and others.

ECE505 Computer Architecture

This course is an introductory graduate course in computer architecture. Most aspects of CPU architecture are covered using a combined hardware/software approach. Specific topics include datapath design, memory systems, microprogramming, memory management, operating systems, and instruction set design.

ECE579M Real-Time System Design

This course focuses on the design of computer systems for which the timeliness of producing results is a critical factor for establishing the correctness of the system design. Topics covered include hardware specification, real-time operating systems and programming, scheduling, communications, and validation/verification. Issues and choices arising for single processor and distributed systems are also covered. Both hard and soft real-time system issues and the interactions between real applications and real systems is stressed.

ECE2010 Introduction to Electrical and Computer Engineering.

The objective of this course is to introduce students to the broad field of electrical and computer engineering within the context of real world applications. This course is designed for first-year students who are considering ECE as a possible major or for non-ECE students fulfilling an out-of-major degree requirement. The course will introduce basic electrical circuit theory as well as analog and digital signal processing methods currently used to solve a variety of engineering design problems in areas such as entertainment and networking media, robotics, renewable energy and biomedical applications. Laboratory experiments based on these applications are used to reinforce basic concepts and develop laboratory skills, as well as to provide system-level understanding. Circuit and system simulation analysis tools are also introduced and emphasized.

ECE2019 Sensors, Circuits, and Systems.

This course investigates commonly used sensors such as resistive temperature sensors, capacitive touch sensors, and inductive motion sensors and actuators. Numerous applications are presented to motivate coverage of fundamental operating principles of circuit elements such as resistors, capacitors, and inductors; model the signals produced by these sensors; and analyze the circuits and systems used to amplify and process these signals. After a review of Kirchhoff's current and voltage laws, fundamental analysis techniques such as Thevenin and Norton's theorems and the superposition principle are used to model and analyze sensors, circuits, and systems. Concepts from analysis of linear, time-invariant continuous-time signals and systems are introduced as necessary, including Fourier series and characterization of systems such as filters in both the frequency domain (bandwidth, transfer function) and time domain (rise time,

step response). Capacitance, inductance and mutual inductance are explored as energy storage elements, including consideration of resonance and energy losses in power systems. Concepts will be reinforced with the use of laboratory exercises and computer simulation. Recommended background: ECE 2010, MA 1024 (or equivalent), PH 1120/21 and MA 2051 (concurrent) Note: Students who have received credit for ECE 2111 may not receive credit for ECE 2019.

ECE2022 Introduction to Digital Circuits and Computer Engineering.

The objective of this course is to expose students (including first year students) to basic electrical and mathematical concepts that underlie computer engineering while continuing an introduction to basic concepts of circuits and systems in a hands-on environment. Experiments representing practical devices introduce basic electrical engineering concepts and skills which typify the study and practice of electrical and computer engineering. In the laboratory, the students construct, troubleshoot, and test analog and digital circuits that they have designed. They will also be introduced to the nature of the interface between hardware and software in a typical microprocessor based computer.

ECE2801 Foundations of Embedded Systems

This course teaches the principles of programming microprocessors and microcontrollers for real-time applications. Students are introduced to software engineering principles and are taught how to translate product specifications into engineering solutions.

ECE2799 ECE Design

This is a new course added to the curriculum that teaches sophomore Electrical Engineering students the basic principles of design. Topics are covered which range from project planning and management through manufacturing and implementation. Students are exposed to external factors influencing design such as safety, liability, cost, and other constraints.

ECE3801 Logic Circuits

This is an introductory course in logic circuit design. Topics covered include Boolean Logic, Algebraic minimization of logic equations, Karnaugh Maps, sequential machine design and timing analysis.

ECE3803 Introduction to Microprocessor Systems

This is an undergraduate-level first-course in microprocessor design. Topics covered include timing analysis, address decoding, memory system design, assembly language programming, programmed I/O, and digital/analog interfacing. Experiments are run using ISA-bus interfaces to standard PCs.

ECE3810 Advanced Digital System Design

This course addresses the design of advanced digital logic systems using VHDL to design, synthesize and model digital circuits, and to implement these circuits using Xilinx FPGA devices. The course emphasizes understanding functional design, designing for speed and power objectives, and testing. The course ends with students designing moderately complicated “system on a chip” (SOC) based systems

ECE4815 Computer Architecture (crosslisted as CS4515)

A first course in computer architecture. Essential aspects of CPU architecture are covered using a combined hardware/software approach. Students learn how a CPU interprets and processes instructions. Issues associated with interfacing hardware with software are covered in detail as are the hardware/software tradeoffs associated with performance optimization.

ECE4801 Microprocessor System Design

Microprocessor System Design is the second course in the microprocessor sequence. In this course, students learn the advanced concepts used in modern microprocessor systems. Topics such as system organization, dynamic and cache memory systems, communications, mixed language programming, and device driver design are covered.

ECE430X Fundamentals of Navigation Systems

This course introduces students to the fundamentals of navigation using electronic systems. The course covers types of navigation systems, how to interpret sensor data and sources of navigation system error. Topics include: types of navigation systems (dead reckoning, inertial, radio based systems), sensors and error sources, coordinate frames and transformations, system dynamics and measurement processing. Case studies explore the use of accelerometers, gyroscopes, GPS (including, differential and assisted GPS) as well as other types of navigation systems.

RBE 3001 Unified Robotics III

Third of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is actuator design, embedded computing and complex response processes. Concepts of dynamic response as relates to vibration and motion planning will be presented. The principles of operation and interface methods various actuators will be discussed, including pneumatic, magnetic, piezoelectric, linear, stepper, etc. Complex feedback mechanisms will be implemented using software executing in an embedded system. The necessary concepts for real-time processor programming, re-entrant code and interrupt signaling will be introduced. Laboratory sessions will culminate in the construction of a multi-module robotic system that exemplifies methods introduced during this course.

RBE 3002 Unified Robotics IV

Fourth of a four-course sequence introducing foundational theory and practice of robotics engineering from the fields of computer science, electrical engineering and mechanical engineering. The focus of this course is navigation, position estimation and communications. Concepts of dead reckoning, landmark updates, inertial sensors, vision and radio location will be explored. Control systems as applied to navigation will be presented. Communication, remote control and remote sensing for mobile robots and tele-robotic systems will be introduced. Wireless communications including wireless networks and typical local and wide area networking protocols will be discussed. Considerations will be discussed regarding operation in difficult environments such as underwater, aerospace, hazardous, etc. Laboratory sessions will be directed towards the solution of an open-ended problem over the course of the entire term.

RBE 400x Robot System Engineering and Design

The designers of robotic systems start with a system requirement to define the mechanical, electrical and software systems which must work together to achieve the system goals. Typically, parallel teams of engineers will work concurrently to create the requirements document as well as model various aspects of the system to verify operational capabilities and the ability to meet time and budget constraints. For complex systems, the development of such teams can itself be a complex problem since the project has to be organized in such a way that parallel teams can work independently, yet have excellent communication channels and information passing to insure project success.

This course explores the tools and techniques used to develop complex systems. The topics covered include: requirements development; system architecture and partitioning; requirements flowdown; functional and interface specifications; trade studies; system modeling and simulation; system integration; as well as design verification and validation.

RBE500 Foundations of Robotics

Foundations and principles of processing sensor information in robotic systems. Topics include an introduction to probabilistic concepts related to sensors, sensor signal processing, multi-sensor control systems and optimal estimation. The material presented will focus on the types of control problems encountered when a robot must operate in an environment where sensor noise and/or tracking errors are significant. Techniques for assessing the stability, controllability and expected accuracy of multi-sensor control and tracking systems will be presented. Lab projects will involve processing live and synthetic data, robot simulation and projects involving the control of robot platforms.

RBE502 Robot Control

This course reviews the interplay between control and robotics through introducing theory and demonstrating applications. It aims to provide an in-depth coverage of control design for robotic manipulators and mobile robots. We focus primarily on fundamental theory, control design methods, and their application on practical robotic systems. Topics may include modeling of robotic systems, linear/nonlinear control of robotic systems, control of under-actuated robotic systems, optimal control, adaptive control, behavior-based robots. Course projects will emphasize modeling, simulation and practical implementation of control systems for robot applications.

RBE594 Capstone Project Experience In Robotics Engineering

This project-based course integrates robotics engineering theory and practice, and provides the opportunity to apply the skills and knowledge acquired in the Robotics Engineering curriculum. The project is normally conducted in teams of two to four students. Students are encouraged to select projects with practical significance to their current and future professional responsibilities. The projects are administered, advised, and evaluated by WPI faculty as part of the learning experience, but students are also encouraged to seek mentorship from experienced colleagues in the Robotics Engineering profession.

3. List of Publications:

3.1 Journal Papers

- [1] V. Diluoffo, W. R. Michalson and B. Sunar, "Robot Operating System 2: The need for a holistic security approach to robotic architectures," *International Journal of Advanced Robotic Systems*, 15.3, 2018.
- [2] T. Padir, W.R. Michalson, et. al., "Implementation of an Undergraduate Robotics Engineering Curriculum," *Computers in Education Journal*, vol. I, no. 3, pp. 92-101, 2010.
- [3] W. R. Michalson, A. Navalekar and H. Parikh, "Error mechanisms in indoor positioning systems without support from GNSS," *The Journal of Navigation*, Cambridge University Press, vol. 62, no. 2, pp. 239-49, 2009.
- [4] H.K. Parikh and W. R. Michalson, "Impulse Radio - UWB or Multicarrier UWB for Non-GPS based Indoor Precise Positioning Systems," *NAVIGATION J. Inst. Nav.*, Vol. 55, no. 1, 2008.
- [5] I. F. Progri, W. R. Michalson, J. Wang and M.C. Bromberg, "Indoor Geolocation Using FCDMA Pseudolites: Signal Structure and Performance Analysis", *NAVIGATION J. Inst. Nav.*, Vol. 54, No. 3, Fall 2007.
- [6] I. F. Progri, M. C. Bromberg and W. R. Michalson, "Maximum-Likelihood GPS Parameter Estimation", *NAVIGATION J. Inst. Nav.*, vol. 52, no. 4, pp. 229-238, Winter, 2005-2006.
- [7] I.F. Progri, W.R. Michalson, and D. Cyganski, "An OFDM/FDMA Indoor Geolocation System," *NAVIGATION J. Inst. Nav.*, vol. 51, no. 2, pp. 133-142, Summer, 2004.
- [8] I.F. Progri, G. Bogdanov, V.C. Ramanna, and W.R. Michalson, "An Investigation Of A GPS Adaptive Temporal Selective Attenuator," *NAVIGATION J. Inst. Nav.*, Vol. 49 No. 3, pp. 137-147, 2002.
- [9] G. Bogdanov, W. R. Michalson, and R. Ludwig, "A new apparatus for non-destructive evaluation of green-state powder metal compacts using the electrical resistivity method," *Measurement Science and Technology*, IOP Publishing, vol. 11, pp. 157-166, January 2000.

- [10] B. Findlen, E. Reuter, R. Campbell, and W. R. Michalson, "Effects of time domain response on the sonic characteristics of microphones," *Journal of the Acoustical Society of America*, vol. 104, no. 3, pt. 2 pp. 1764, September 1998.
- [11] J. Sedgwick, W. R. Michalson, and R. Ludwig, "Design of a Digital Gauss Meter for Precision Magnetic Field Measurements," *IEEE Transactions on Instrumentation and Measurement*, vol. 47, no. 4, pp. 972-977, August 1998.
- [12] J. Stander, J Plunkett, W. Michalson, J. McNeill, and R. Ludwig, "A Novel Multi-Probe Resistivity Approach to Inspect Green-State Powdered Metallurgy Compacts," *Journal of Non-Destructive Evaluation*, vol. 16, no. 4, pp. 205-214, 1997.
- [13] Woltereck, R. Ludwig, and W. Michalson, "A Quantitative Analysis of the Separation of Aluminum Cans Out of a Waste Stream Based on Eddy Current Induced Levitation," *IEEE Transactions on Magnetics*, vol. 33, no. 1, pp. 772-781, January 1997.
- [14] W. R. Michalson, "Auralization on a Laptop PC," abstract appears in *The Journal of the Acoustical Society of America* , vol. 100 No. 4, Pt 2, pp. 2608, October 1996.
- [15] R. H. Campbell, S. K. Martin, I. Schneider, and W. R. Michalson, "Analysis of Mosquito Wingbeat Sound," *The Journal of the Acoustical Society of America* vol. 100 No. 4, Pt 2, pp. 2710, October 1996.
- [16] W. R. Michalson, "Ensuring GPS Navigation Integrity using Receiver Autonomous Integrity Monitoring," *IEEE Aerospace and Electronic Systems Magazine*. vol. 10, no. 10, pp. 31-34, October 1995.
- [17] S. Clayton, R. J. Duckworth, W. Michalson, A. Wilson, "Determining Update Latency Bounds in Galactica Net," *Concurrency: Practice, and Experience*, vol. 7, no. 7, pp. 595-611, October 1994.

3.2 Conference Papers

- [1] E. Skorina, R. Rameshwar, S. Pirasmepulkul, T. Khuu, A. Caracappa, P. Luxsuwong, M. Luo, W. R. Michalson, and C. Onal, "Soft Robotic Glove System for Wearable Haptic Teleoperation," WM Symposium 2018, March 18 - 22, 2018 - Phoenix Convention Center.
- [2] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Using Both GPS L1 C/A and L1C: Strategies to Improve Acquisition Sensitivity," Proc. 26th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2013), Sep. 16-20, 2013.
- [3] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Semi-Coherent and Differentially Coherent Integration for L1C Acquisition," Proc. 2013 International Technical Meeting of the Institute of Navigation (ION ITM 2013), Honolulu, HI, Apr. 22-25, 2013.
- [4] J.M. Barrett, M.G. Gennert, W. R. Michalson, et. al., "Development of a Low-Cost, Self-Contained, Combined Vision and Inertial Navigation System," 2013 International Conference on Technologies for Practical Robotic Applications, Boston, MA Apr. 22-23, 2012.

- [5] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Analysis of L1C Acquisition by Combining Pilot and Data Components Over Multiple Code Periods," Proc. 2013 International Technical Meeting of the Institute of Navigation (ION ITM 2013), San Diego, CA, Jan. 28-30, 2013.
- [6] K.C. Seals, W.R. Michalson, R.J. Hartnett and P.F. Swaszek, "Analysis of Coherent Combining for L1C Acquisition," Proc. 25th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS 2012), pp.384-393, Nashville, TN, Sep. 17-21, 2012.
- [7] J.M. Barrett, M.G. Gennert, W. R. Michalson and J.L. Center, "Analyzing and Modeling an IMU for Use in a Low-Cost Combined Vision and Inertial Navigation System," 2012 International Conference on Technologies for Practical Robotic Applications, Boston, MA Apr. 23-24, 2012.
- [8] G. Fischer, W. R. Michalson, T. Padir and G. Pollice,"Development of a Laboratory Kit for Robotics Engineering Education" AAAI 2010 Spring Symposium on Educational Robotics and Beyond: Design and Evaluation, Mar. 22-24, Palo Alto, CA, 2010.
- [9] W.R. Michalson, and F. J. Looft, "Designing Robotic Systems: Preparation for an Interdisciplinary Capstone Experience," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [10] W.R. Michalson, S.J. Bitar and R.C.Labonte, "The Technical, Process, and Business Considerations For Engineering Design – A 10 Year Retrospective," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [11] M. Gennert, M. Demetrio and W. R. Michalson, "A Robotics Engineering M.S. Degree," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [12] R. Beach, W. R. Michalson, et. al., "Robotics Innovations Competition and Conference (RICC): Building Community Between Academia and Industry Through a University-Level Student Competition," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [13] G. Tryggvason, W.R. Michalson, et. al., Teaching Multidisciplinary Design to Engineering Students: Robotics Capstone," American Society of Engineering Educators 2010 Annual Conference, Louisville, KY, Jun 20-23, 2010.
- [14] A.C.Navalekar, W.R. Michalson, "Asymmetric throughput problem due to Push-to-talk (PTT) delays in CSMA/CA based heterogeneous Land Mobile Radio (LMR) networks", accepted for publication, Milcom 2009.
- [15] A. Navalekar and W.R. Michalson, "Effects of Unintentional Denial of Service (DOS) due to PTT delays on performance of CSMA/CA based Adhoc Land Mobile Radio (LMR) networks", accepted for publication, ICST Adhocnet 2009.
- [16] W. R. Michalson, et. al., "Unified Robotics: Balancing Breadth and Depth in Engineering Education", American Society of Engineering Educators 2009 Annual Conference, AC 2009-1681, Austin, TX, Jun 14-17, 2009.

- [17] G. Tryggvason, W.R. Michalson, et. al., "Robotics Engineering: A New Discipline for a New Century", American Society of Engineering Educators 2009 Annual Conference, AC 2009-997, Austin, TX, Jun 14-17, 2009.
- [18] M. DiBlasi, W. R. Michalson, et. al., "Social Networking in the FIRST Robotics Competition Community," ASEE Northeast Section Conference, University of Bridgeport, Apr 3-4, Bridgeport, CT, 2009.
- [19] A. Navalekar, H.K Parikh and William R. Michalson, "Error Mechanisms in Indoor Positioning Systems without Support from GNSS", RIN NAV 08.
- [20] A. Navelekar, W.R. Michalson, et. al., "Effects of Push-To-Talk (PTT) delays on Throughput Performance of CSMA/CA based Distributed Digital Radios (DDR) for Land Mobile Radio (LMR) Networks," 37th International Conference on Parallel Processing (ICPP-08), Portland, OR, Sep. 8-12, 2008.
- [21] M. Ciraldi, W. Michalson, et. al., "The New Robotics Engineering BS Program at WPI," American Society of Engineering Educators 2008 Annual Conference, AC 2008-1048, Pittsburgh, PA, Jun 22-25, 2008.
- [22] A.C.Navalekar, W.R. Michalson, "A New Approach to Improve BER Performance of a High Peak-to-Average Ratio (PAR) OFDM signal over FM based Land Mobile Radios (LMR)", IEEE WTS 08, Pomona, CA.
- [23] A. Navelekar and W.R. Michalson, "Effects of Push-To-Talk (PTT) delays on CSMA based Capacity Limited Land Mobile Radio (LMR) Networks," *Proc. IEEE Intl. Symp. Wireless Pervasive Computing 2008 (ISWPC08)*, Santorini, Greece, May 7-9, 2008.
- [24] H.K. Parikh and W.R. Michalson, "Error Mechanisms In An Rf-Based Indoor Positioning System," *Proc. 2008 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP '08)*, Las Vegas, NV Mar 30 – Apr 4, 2008.
- [25] B. Woodacre, W. Michalson, et. al., "WPI Precision Personnel Locator System - Automatic Antenna Geometry Estimation," to appear, *Proc. ION-NTM 2008*, San Diego, CA, Jan 27-29, 2008.
- [26] H.K. Parikh, A. Navelekar and W.R. Michalson, "Issues in Achieving Precise Positioning Indoors Without Support from GNSS," *Proc. ION-NTM 2008*, San Diego, CA, Jan 27-29, 2008.
- [27] D. Cyganski, W. Michalson, et. al., "WPI Precision Personnel Locator System - Evaluation by First Responders," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.
- [28] I.F. Progri, W. R. Michalson, et. al., "Maximum Likelihood OFDMA Parameter Estimation," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.
- [29] C.W. Kelley, W. R. Michalson, et. al., "Discrete vs. Continuous Carrier Tracking Loop Theory, Implementation, and Testing with Large BnT," *Proc. Institute of Navigation GNSS 2007*, Fort Worth, TX, September 25-28, 2007.

- [30] W. R. Michalson and J. W. Matthews, "Distributed Digital Radios and WLAN Interoperability," 2007 IEEE Conference on Technologies for Homeland Security, May 16-17, Woburn, MA, 2007.
- [31] I.F. Progri, W.R. Michalson, J. Wang, M.C. Bromberg, and R.J. Duckworth, "Requirements of a C-CDMA Pseudolite Indoor Geolocation System," *Proc. ION-AM 2007*, Cambridge, MA, pp. 654-658, Apr. 2007.
- [32] D. Cyganski, R. J. Duckworth, S. Makarov, W. R. Michalson, et.al., "WPI Precision Personnel Locator System," *Proc. Institute of Navigation National Technical Meeting (NTM 2007)*, Catamaran Resort Hotel, San Diego, CA, January 22-24, 2007.
- [33] I.F. Progri, M.C. Bromberg, W.R. Michalson, and J. Wang, "A Theoretical Survey of the New GPS Signals (L1C, L2C, and L5)," *Proc. Institute of Navigation National Technical Meeting (NTM 2007)*, Catamaran Resort Hotel, San Diego, CA, January 22-24, 2007.
- [34] I.F. Progri, M.C. Bromberg, W.R. Michalson, and J. Wang, "Field Measurement Data on Support of a Unified Indoor Geolocation Channel Model," *Proc. Institute of Navigation National Technical Meeting (NTM 2007)*, Catamaran Resort Hotel, San Diego, CA, January 22-24, 2007.
- [35] I. F. Progri, J. Maynard, W.R. Michalson, and J. Wang, "The Performance and Simulation of a C-CDMA Pseudolite Indoor Geolocation System," *Proc. Institute of Navigation GNSS 2006*, Fort Worth, TX, September 26-29, 2006.
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3.3 Book Chapters

- [1] W. Michalson and E. Schnieder, "An Approach for Implementing a Reconfigurable Optical Interconnection Network for Massively Parallel Computers," in *Optical Interconnection - Foundations and Approaches*, C. Tocci and H. J. Caulfield Eds., Artech House, proposed release January 1994.

3.4 Patents

Haptic glove as a wearable force feedback user interface

United States Patent 10,551,923, Issued February 4, 2020

A toroidal actuator is responsive to a teleoperator for providing haptic feedback responsive to a curvature or articulated movement applied to a gripped object. The toroidal actuator surrounds an operator member such as a finger, and is responsive to pneumatic pressure for increasing telepresence force defined by resistance encounter against a teleoperated robotic claw. As the teleoperated claw grips an object, increased pneumatic pressure in the toroidal actuator tends to elongate the toroidal shape in a linear manner and oppose a curvature force applied by an inserted operator finger. Resistive force is based on soft sensing of the gripped object, thus the toroidal actuator applies an increasing resistive force to curvature as the robotic claw closes around a gripped object by solenoid regulated air pressure.

Precision location methods and systems

United States Patent 8,928,459, Issued January 6, 2015

The invention describes systems and methods for determining the location of a transmitter by jointly and collectively processing the full sampled signal data from a plurality of receivers to form a single solution.

Tracking device and remote monitoring system

United States Patent Application US20140274115A1

A system includes a remote monitoring device configured to detect and measure one or more signals and to convey detected and measured signal information to a central location. The central location is configured to determine the location of the remote monitoring device based on the received signal information and is also configured to determine at least one hypothetical path of the remote monitoring device. Abandoned.

Apparatus and methods for addressable communication using voice-grade radios

United States Patent 8,284,711, Issued 9 October 2012

The invention relates to methods and apparatus for conducting directed communication using voice-grade radios. The methods and apparatus can be used to form a packet-switched wireless network using legacy analog transceivers, providing, e.g., both data and voice-over-Internet Protocol communication.

Multi-channel electrophysiologic signal data acquisition system on an integrated circuit.

United States Patent 7,896,807, issued 3 March 2011.

A physiologic data acquisition system includes an analog input, a sigma-delta front end signal conditioning circuit adapted to subtract out DC and low frequency interfering signals from and amplify the analog input before analog to digital conversion. The system can be programmed to acquire a selected physiologic signal, e.g., a physiologic signal characteristic of or originating from a particular biological tissue. The physiologic data acquisition system may include a network interface modulating a plurality of subcarriers with respective portions of an acquired physiologic signal. A receiver coupled to the network interface can receive physiologic data from, and send control signals and provide power to the physiologic data acquisition system over a single pair of wires. The network interface can modulate an RF carrier with the plurality of modulated subcarriers and transmit the resulting signal to the receiver across a wireless network. An integrated circuit may include the physiologic data acquisition system. Also included are methods for acquiring physiologic data comprising the step of selectively controlling an acquisition circuit to acquire the physiologic signal.

Methods and apparatus for high resolution positioning. United States Patent 7,292,189. The invention relates to a method of signal analysis that determines the location of a transmitter and to devices that implement the method. The method includes receiving by at least three receivers, from a transmitter, a first continuous-time signal having a first channel. The first channel includes a first plurality of signal carriers having known relative initial phases and having known frequencies which are periodically spaced and which are orthogonal to one another within a first frequency range. The signal analysis method also includes determining the phase shifts of the carriers of the first channel resulting from the distance the carriers traveled in reaching the first receiver. Analysis of the phase shifts yields time difference of arrival information amongst the receivers, which is further processed to determine the location of the transmitter. 6 Nov 2007.

A Reconfigurable Indoor Geolocation System, US Patent Number 7,079,025. A portable reconfigurable geolocation system is provided. The system includes a portable user node and one or more portable pseudolite nodes in communication one another and with the user node. Each of the user nodes and pseudolite nodes includes a transmitter that generates a signal on one or more carrier frequencies. Each signal is modulated with digital signals necessary to establish distances between the nodes and to convey data between the nodes. Each node also includes a receiver for receiving and demodulating the signals transmitted between the nodes, and a processor for receiving the demodulated signals, extracting data values and derived values from the demodulated signals and determining a three-dimensional position of each node in the system. Issued 18 Jul 2006.

Auto-Calibrating Surround System, United States Patent 7,158,643. A multi-channel surround sound system and method is described that allows automatic and independent calibration and adjustment of the frequency, amplitude and time response of each channel of the surround sound system. The disclosed auto-calibrating surround sound (ACSS) system includes a processor that generates a test signal represented by a temporal maximum length sequence (MLS) and supplies the test signal as part of an electric input signal to a loudspeaker. A microphone coupled to the processor receives the signal in a listening environment. The processor correlates the received sound signal with the test signal in the time domain and determines from the correlated signals a whitened response of the audio channel in the listening environment. Issued 2 Jan 2007.

Hand-held GPS-mapping device, US. Patent Number 5,987,380. A hand-held navigation, mapping and positioning device contains a GPS receiver, a database capable of storing vector or bit mapped graphics, a viewing port, an embedded processor, a simplified user interface, a data compression algorithm, and other supporting electronics. The viewport is configured such that the data presented in the viewport is clearly visible in any ambient light condition. The database stores compressed image data which might include topographical map data, user annotations, building plans, or any other image. The system includes an interface to a personal computer which may be used to annotate or edit graphic information externally to the device for later upload. In addition, the device contains a simple menu-driven user interface which allows panning and zooming the image data, marking locations of interest, and other such functions. The device may be operated from an internal rechargeable battery, or powered externally. Issued 16 Nov 1999.

Hand-held GPS-mapping device, US. Patent Number 5,902,347. A hand-held navigation, mapping and positioning device contains a GPS receiver, a database capable of storing vector or bit mapped graphics, a viewing port, an embedded processor, a simplified user interface, a data compression algorithm, and other supporting electronics. The viewpoint is configured such that the data presented in the viewport is clearly visible in any ambient light condition. The database stores compressed image data which might include topographical map data, user annotations, building plans, or any other image. The system includes an interface to a personal computer which may be used to annotate or edit graphic information externally to the device for later upload. In addition, the device contains a simple menu-driven user interface which allows panning and zooming the image data, marking locations of interest, and other such functions. The device may be operated from an internal rechargeable battery, or powered externally. Issued 11 May 1999.

3.5 Professional Presentations

American Ambulance Association Annual Meeting: Low-cost VHF/UHF Interoperability for digital telemetry, Las Vegas, NV, Dec. 2005.

California Ambulance Association, Keynote address: Alternatives to solving interoperability problems in Land Mobile Radios, Lake Tahoe, NV, July 2005.

Museum of Science Lecture Series: The Next Generation of Information and Communications Technologies-What does the Future Hold?, William R. Michalson and Brian King, January 14, 2004.

Agilent Wireless Technology Summit: Dynamic Node Location in an Ad Hoc Indoor Communications and Positioning Network, William R. Michalson, January 27, 2004

Security & Technology Online (SATO) Security Leadership Council. Panel discussion on Smart Surveillance, Command and Control, Oct 28-29, 2004.

“*Worcester Polytechnic Institute Barcelona Summit: The Future of Information Technology*,” delivered presentation entitled “Personal Navigation in the Information Age,” Apr 2001.

4. Projects advised (undergraduate).

4.1 Major Qualifying Projects (current)

- [1] *Formula SAE Electric*, S. V. Boyd, T.A., T.A. Ninesling, E.R. Robert, J.M. Duffield, B.P. Steeves, J.B. Chase, N.S. Bajakian, N.R. Alescio, R.D. Johnson, C.L. Besch, T.R. Schaeffer, MQP-DCP-AB82/MQP-WZM-EV21, 2021.
- [2] *SailBot 2021*, C.J. Burri, M.J. Laks, L.C. Zebrowski, N.H. Jackson, C.J. Scholler, N.J. Eusman, A.V. Thammana, MQP-WZM-SB21, 2021.
- [3] *Ship Recycling Robot*, N.M. Kalsih, S.I. Morales, J. Cybul, J.D. Hoy, T.H. Reiser, MQP-BC2-SRR1, 2021.
- [4] *Tethered Submersible Surveyor*, B.L. Ward, L.C. Reid, J.A. Conklin, J.Y. Huang, MQP-YGB-SUB2/MQP-WZM-SUB1, 2021.
- [5] *Underwater Communications*, L. Spalding, MQP-WZM, 2021.
- [6] *Lionfish III*, MQP-CBP, 2021.

4.2 Major Qualifying Projects (completed)

- [7] **Remote Water Monitoring*, Daniel Shrives, T. Vose, and B. Rolfes, MQP-WZM-AB0R, 2020. [* Winner – Provost’s MQP Award in Robotics Engineering]
- [8] *SailBot 2019-2020 MQP*, I. Lavryonova, T. Andrews, M. Guzman, and K. Reese, MQP-WZM-ABWT, 2020.
- [9] *Firefighting Remote Exploration Device II*, J. Cheng, D. Karavoussianis, A. Moseley, and L. Sahyun, CP4-MQP-FIRE, co-advised, 2020.
- [10] *Mohamed Bin Zayed International Robotics Challenge at Takemura Lab, Osaka University*, N. Greig and D. McHorney, WZM-MQP-ABVE, 2020
- [11] *Lionfish Harvesting Robot – Phase III*, M. Abadjiev, Q. Chen, C. Ewen, N. Johnson, N. Olgado, H. Saperstein, O. Strickland, and C. Whimpenny, WZM-MQP-ABVF, 2020.

- [12] *Underwater 3D Data Collection*, D. Pelaez, T. LaCroce, and N. Budris, WZM-MQP-ABVK, 2020.
- [13] *Efficient Multi Robot Mapping: Quick and Sustained Environmental Surveying with Limited Communication*, D. Abraham, T. Bergeron, and C. Dembski, WZM-MQP-AB0P
- [14] *Leveraging NVMe Management Interface to Provide SES Support for Enterprise Server Diagnostics*. T. P. Mackintosh, WZM-MQP-ABQ3, 2019.
- [15] *Sailbot 2018-19*. S. T. Palmer, K.B. Randall and S. A. Fisher, MQP-KZS-SBOT/MQP-WZM-SAIL, 2019.
- [16] *Firefighting Remote Exploration Device*, E. M. Barinelli, J. L. Berman-Jolton, G. K. MacNeal, K. R. Naras, M. Tasellari, and Y. A. Verdeja. MQP-CP4-ABQE, 2019.
- [17] *Vertical Take-Off and Landing Autonomous Aircraft Design*, Q. C. Barker, T. P. Bergeron, J. A. Goldsberry, J. Romelle, B. H. Pasculano, B. M. Waterman, T. M. Weiss, and Z. J. Zolotarevsky, MQP-RVC-1901, 2019.
- [18] *Mobile Manipulation Testbed*, N. S. Dennler, M. LeMay, and T. J. Macaluso, MQP-WZM-AD19, 2019.
- [19] *K.O.L.T.: Known Object Localization and Mapping*, N. A. Rosenberg, MQP-WZM-DRMP, 2019.
- [20] *Walking Quadrupedal Platform*, N. C. Franco, N. M. Liedtke, and D. Lu, MQP-WZM-QUAD, 2019.
- [21] *Wolfgang: An Autonomous Mobile Robot for Outdoor Navigation*, A. U. Cookson, M.E. Landergan, and S. T. O’Neil, MQP-XIH-AD19, 2019.
- [22] *MGH Biomedical Imaging Tools*, I. Alexiou, MQP-SNM-SNMA, 2019. *Automated Sandwich Assembly*, Derek W. Feehrer, Carter C. Reynolds, Jaime R. Stephen, Taylor A. Stephen, MQP WZM 17A1, 2018.
- [23] *Localization for FRC*, Hu, J., Mitrano, P., Puczydowski, K. and Vere, N., 2017.
- [24] **Sailbot 2017-2018 Final Report*, Burklund, J., Johnson, H., Norris, T. and Shanahan, L. 2018. [* Winner – Provost’s MQP Award in Robotics Engineering, Winner – Professional Writing Award].
- [25] *QRP – Quadrupedal Robotics Platform*, Armsby, Z., Cole, R., Coll, B., Martin, J., and Nagal, A., 2018.
- [26] *Embedded GPU-Based Image & Signal Processing Prototype*, Baker, L and Song, D. Lincoln Laboratories, 2018.
- [27] *Music and Wearable Technology*, Perry, L.M., Ferguson, E.E., Barreiro, M.P., 2017.
- [28] *Collaborative Robotics Heads-Up Display*, Christopher Bove and Alexander Wald, MQP-WZM-16A1, Lincoln Laboratories, 2017.
- [29] *Low Cost Quadrupeds*, Joshua Graff, Kevin Maynard, and Alonzo Martinz, MQP-WZM-16A2, 2017.
- [30] *Fire Response Drone*, John Lomi, Zachary Hood, Kyle Young, Chase St. Laurent, and William Boyd, MQP-WZM-16A3, 2017.

- [31] *Smart Transradial Prosthesis*, Yesugey Sipka, ID-CDO-1603, 2017
- [32] **Sailbot 2016*, Nicholas Gigliotti, James Kuszmaul, Tucker Martin, and Ryan Wall, 2016. [* nominated for the Provost's MQP Award in Computer Science].
- [33] *Autonomous Snowblower*, Nicholas Rowles, Daniel Pongratz, Harrison Vaporciyan, , 2017.
- [34] **Body Armor Impact Map System*, Carolyn S. Keyes, ME; Nicholas B. Potvin, ECE; and Zachary R. Richards, CS, MQP-WZM-15A1, 2016. [* winner of the Mechanical Engineering Department's MQP Award].
- [35] *Highway Safety Merge System*, Dante A. Pace, ECE; and Sunghoon Yoon, CS, MQP-MYE-AAS5, 2016.
- [36] *Highway Safety Merge System*, Christopher M. Ellen, RBE; MQP-MYE-AATK, 2016.
- [37] *Collaborative Robotics Heads-Up Display*, Bove, C.P. and Wald, A., WPI Lincoln Laboratories Project Center, 2016.
- [38] *De-Mining with UAVs*, Gregory G Tighe
- [39] *Arc-Liberation of Intermolecular Bond Energy for Marine Propulsion*, Rohan Jhunjhunwala, ME; James Deane Jackman, CS; Tyler Jon Ewing, ME; Christopher Michael Byrne, ECE; Christopher William Egan, ECE, 2015.
- [40] *Glovesense Data Glove*, Nathan William Joseph Wiegman, ECE,; Nathan Harrison Wells, ECE; Russell Hagan Hedlund, ECE,; and Mert Can Erad, ECE, 2015.
- [41] *Mobile Motion Capture*, Robert Patrick Dabrowski, ID; and Matthew Stephen Costi, ID, 2014.
- [42] *Intelligent LED Display*, Harrison Chabot Williams, ECE; Rayce Coleman Stipanovich, ECE; and Alexander Joseph Ryan, ECE, 2014.
- [43] **Design and Optimization of a FSAE Vehicle*, Justin Shane Paprota, ECE; and Camden Ryan Mallette, ECE, 2014. [* winner of the Provost's MQP Award in Mechanical Engineering].
- [44] *Sailboat Stabilization System*, Steven Mize Rutledge, ECE; Pedro John Miguel, ECE; Dominic Student author Gonzalez, ECE; and Michael Eric Brendlinger, RBE, 2014.
- [45] *Real Time Person Tracking and Identification using the Kinect sensor*, Nikolaos Matthiopoulos and Matthew Francis Fitzpatrick, 2013.
- [46] *H.E.A.T. – Home Energy Automation Technology*, John Thomas Manero, ECE; Scott James Cloutier, ECE; Michael Dominick Audi, ECE-RBE, 2012.
- [47] *Automated Refueling for Hovering Robots*, Raymond P. Short, RBE; Janine S. Pizzimenti, RBE; and Nigel Bowers Cochran, RBE, 2012.
- [48] *Improved Intelligence and Systems Integration for WPI's UGV – Prometheus*, Gregory Duncan McConnell, RBE; Samson Michael King, RBE; Craig Alan DeMello, RBE; Michael A. Rodriguez, RBE; and Eric J. Fitting, ID, 2012.

- [49] *Aeacus – development of a bio-inspired robotic platform for swarm-based multi-object transport over uneven terrain*, N. Anderson, D. Praetorius and C. Roddy, co-advised with S. Nestinger, 2011.
- [50] *Realization of Performance Advancements for WPI's UGV-Prometheus*, M. Akmanalp, R. Doherty, J. Gorges, P. Kalasuskas, E. Peterson and F. Polido, co-advised with T. Padir, S. Nestinger, M. Ciraldi, K. Stafford, 2011.
- [51] *Optimization of an Autonomous Underwater Vehicle*, J. Baker, C. Frumento, J. Grzyb and T. North, co-advised w/I. Hussein, 2011.
- [14] *Intelligent Tactical Vest*, V. Brisian, J. Fernando, A. Khandaker and J. Zorrilla DeLos Santos, 2011.
- [15] *Quadrotor UAV Interface and Localization Design*, N. Smith, B. Berard and C. Pietre, Lincoln Laboratory Project Center, co-advised with G. Heineman, 2011.
- [16] *Voice Release System*, J. Low, WZM-MQP-1M10, 2010.
- [17] *Design and Realization of an Intelligent Unmanned Ground Vehicle*, J. Barrett, B. Roy and D. Sacco, Co-Advised w/T. Padir, 2010.
- [18] *Real-time Digital Modeling of analog circuitry for audio applications*, B. Gleason, WZM-MB09, 2010.
- [19] *Optimization and Control Design of an Autonomous Underwater Vehicle*, D. Moussette, A. Palooparambil, and J. Raymond, AE- IHH-0003, co-advised w/I. Hussein, 2010.
- [20] *Design of Autonomous Underwater Vehicle and Optimization of Hydrodynamic Properties and Control*, R. David, WZM-3A08, 2009.
- [21] *Autonomous Vehicle Control*, Breznak, R. S., Cunningham, A. G and Kleinfeld, Z., 2008.
- [22] *Roof Robot Phase 2*, Zachary James Strowe, ECE; and Xu Lin, ECE, 2008.
- [23] *The Thumper Robotic Bass*, B. Kosherick, M. Brown, and A. Teti, WZM-RB08, 2008.
- [24] *Public Safety Integration Center*, P. Lucia, I. Levin and M. Barone, WZM-1A08, 2008.
- [25] *Aircraft Lasercom Terminal Compact Optical Module*, B. Scoville and S. Rose, Lincoln Laboratory Project Center, WZM-2A08, 2008.
- [26] *PANSAT Triple Modular Redundant (TMR) Satellite Flight Computer v3*, Kevin Zhang, ECE; and Karim G. Makram, ECE, 2006.
- [27] *GPS Attitude Determination System*, J.P. Salmon, Michael LaBossiere and Mark Minotaur, 2005.
- [28] *FPGA Implementation of an OFDM Modem*, Andrew Dupont and Jack Coyne, 2005.
- [29] *TREMOR – A Triple Modular Redundant Flight Computer for WPI's PANSAT – Revision 2*, Maulin Patel, Omar Moussa and Matthew Kwiatkowski, 2005.
- [30] *Construction of a GPS Pseudolite*, Tim Coffey, 2005.
- [31] *Dipole Antenna Placement in a Falcon-20 Aircraft*, Emily Anesta and David Plourde, Lincoln Laboratories Project Center, A-Term, 2004.

- [32] *GPS Attitude Determination System*, Joshua Holwell, Himanshu Agrawal and Andrew Coonradt, 2004.
- [33] *TMR Computer System*, Ryan Angilly, Mitch Lauer and Dan Debiasio, 2004.
- [34] *Personal Inertial Navigation System*, Jason DeChiaro and Christopher Strus, 2003.
- [35] WZM-MQP-4A02: *PC I/O in High Stress Environments*, John Niesz and James Kent, 2003.
- [36] WZM-MQP-2A02: *Vacuum Tube Amplifier*, Joseph Kambourakis and Gregory Molnar, 2003.
- [37] *Container Tracking System*, Victoria Chaplick, 2003.
- [38] WZM-MQP-2A03: *Heat Management System for PCs*, Ernest Cardin, Kevin Candiloro and Stephen Leavey, 2002.
- [39] WZM-MQP-1313: *Digital Image Enhancement*, Julie Bolduc, Joeseeph Perry, Wei Fu, 2002.
- [40] WZM-MQP-2A01: *Synchronized Audio Sample Looper*, Joel Gottshalk, Robert Conrad and Sanford Freedman, 2002.
- [41] WZM-MQP-1A01: *Springboard Digital Multimeter*, Pavel Loven and Andrew Young, 2002.
- [42] *Ballistic Missile Defense Analysis Toolkit*, Winfield Peterson, Doug Tilkin and Benjamin Wilson, Lincoln Laboratories Project Center, 2002.
- [43] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).
- [44] WZM-MQP-1A00: *StrongArm-Based Computer System*, Bradford Snow, 2001.
- [45] WZM-MQP-1C01: *PC Controlled Laser Light Show Device*, Joel Smith, 2001.
- [46] WZM-MQP-1E00: *PIC-based MIDI Sequencer* Malcolm Beaulieu, 2001.
- [47] WZM-MQP-2A00: *Automotive PC Development Platform* Travis Pouliot and David Philips, 2001.
- [48] *The RoadCom Automotive Computing System*, Benjamin Kennedy and John Pong, 2000.
- [49] WZM-MQP-1A99: *Compressed Sample Wavetable Synthesizer*, Justin Brzozoski, 2000.
- [50] WZM-MQP-3499, *Automatically Equalizing Monitor*, Fernando Braghin, Tenzin Lama, Rahul Bhan and Dion Soetadi, 2000.
- [51] 99D163M: *Railroad Communication*, Benjamin Richards, 2000.
- [52] CS-MXC-IE00: *PIC Real-Time Sequencer*, Alexander Goodrich, 2000.
- [53] 99D514M: *Design of a Microphone Preamplifier*, Eric Reuter, 2000.
- [54] WZM-MQP-1A99, *MPEG Audio Deck*, Justin Brzozoski, 2000.
- [55] *Digital Image Enhancement*, Julie Bolduc, Wei Fu and Joseph Perry, 2000.
- [56] WZM-MQP-4A98, *Railroad Communications System*, Matthew Lug, 1999.
- [57] 99D078M: *Modular Effects Processor II*, Erik Neyland, 1999.

- [58] 99D176M: *Portable Digital Audio Recorder* Eric Toledo and Duc Truong, 1999.
- [59] EE-WZM-1A97, *C Sound Synthesizer*, Ross E. Borgeson, Michael W. Hamel and Matthew S. Walsh, 1998.
- [60] EE-WZM-4A97, *Firewire Audio Device*, Daniel R. Stutzbach, 1998.
- [61] EE-WZM-2A97, *Modular Effects Processor*, Michael J. Dellisanti, 1998.
- [62] EE-WZM-3A97, *GPS Personal Navigation*, Jeffery A. Alderson and Helder Machado, 1998.
- [63] HU-FB-CS01, *C Sound Synthesizer*, Peter W. DeBonte (co-advised).
- [64] EE-WZM-1E97, *PM Measurement System*, Yevgeniy Bogdanov.
- [65] EE-REL-C008, *Design and Development of a Microprocessor-Based Gaussmeter*, David M. Burnham.
- [66] EE-WZM-RC01, *Acoustic Guitar Amplifier*, Christopher Thomas.
- [67] EE-WZM-GSD1, *Guitar Sustaining Device*, Paul D'Ambra.
- [68] EE-RXV-5260, *Audio Feedback Elimination System*, Ross D. Pease and John R. Pelliccio.
- [69] EE-RJD-M963, *Embedded Systems Design*, Christopher A. Briggs and Anthony J. Viapiano.
- [70] EE-WHE-9601, *GPS Hazard Detector*, Michael Roberts, William Cidela, and Chris Mangiarelli.
- [71] EE-WZM-2C96, *Flexible Synthesis*, Noah T. Vawter and Luke Demoracski.
- [72] EE-WZM-1A96, *Tap Dancer MIDI Interface*, Thomas Trela and William Dowell.
- [73] EE-WZM-2A96, *GPS Hazard Detector II*, Will Brothers, Jon Day, and John Zaghi.
- [74] EE-WZM-3A96, *Loudspeaker Data Acquisition System*, Adam Gross.
- [75] EE-WZM-4A96, *Audio Morphing Processor*, William Butterfield and Ted Phipps.
- [76] EE-WZM-5A96, *Acoustic Modeling*, Peter DeBonte.
- [77] EE-WZM-1B96, *Distributed Audio Controller*, Stephen S. Richardson.
- [78] EE-WZM-1A95, *Acoustic Hazard Meter*, Ronald D. Slack.
- [79] EE-WZM-2A95, *Forest Service DGPS*, Joshua J. Single and Michael T. Spadazzi.
- [80] EE-WZM-1C95, *Audio to MIDI Converter*, Jennifer R. Principe.
- [81] EE-WZM-1D95, *Low Cost Auralizer*, Jason R. Hills and Mark R. Paulson.
- [82] EE-WZM-3A95, *Passive Radiator Design*, Kevin R. Weldon.
- [83] EE-WZM-1C94, *Char Model Generation*, Colin J. Florendo.
- [84] EE-WZM-1D94, *Wide Area DGPS Simulator*, Daniel Cohen and Robert Schroter.
- [85] EE-WZM-2D94, *Digital Soundcard*, Timothy Alsberg (Russian Project Center).

- [86] EE-WZM-3D94, *Digital Univibe*, Andrew Willis and Daniel Toohey.
- [87] EE-WZM-1A94, *DSP Based Real-Time Audio Feedback Eliminator*, Kevin M. Eddy.
- [88] EE-WZM-2A94, *Digital LCD Oscilloscope*, William F. Brown and John F. Ebersole.
- [89] 93D236M, *MIDI Mapper*, Jonathan Kemble and Brian Candiloro.
- [90] EE-WZM-1C93, *Fault-Tolerant Computer*, Frederick N. Parmenter.
- [91] EE-WZM-1A93, *Wireless MIDI Controller*, Sanjay Raja, Charles Cimalore, Ty Panagoplos.
- [92] EE-WZM-2A93, *Multiple Pitch Detector*, Jeanne A. Sawtelle.
- [93] EE-WZM-3A93, *Multiprocessor Cache Coherence*, Lauren C. Lind and Norman E. Rhodes.
- [94] EE-WZM-1C92, *A Simulation of the DLX Architecture*, Lisa Harlow.
- [95] EE-WZM-2C92, *A New Microprocessor Development System*, Gregory B. Burlingame, David J. Fortin, Kevin S. Pearson.
- [96] EE-WZM-1A92, *Digital Audio Sampler*, Roger D. Gagnon and James M. Lach.
- [97] EE-WZM-2A92, *Intelligent Harmonizer*, Prabhjot S. Anand and Aftab M. Yusuf.
- [98] EE-WZM-3A92, *Computerized Audio Mixer*, Richard J. Wood.
- [99] EE-WZM-1B92, *Real-Time Harmonizer*, Mohiuddin M. Kahn.
- [100] EE-WZM-1A91, *Residue Number System Processor*, Ravdeep S. Anand and Christine A. Easton.
- [101] EE-WZM-2A91, *SCSI Bus Analyzer*, Brian Costello, George Delouriero, Matthew Maguire, and Keith Nevins.

4.3 Interactive Qualifying Projects (completed)

- [1] *Bell Towers*, Bowman, I.H., Casciola, I.O., Adiletta, M.J., Bruneau, C.D., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [2] *Creating a Circular Economy with Urban Farming*, Ward, B.L., Cyran, B., Premo, J., Soens, N., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [3] *Plastic-Free Venice*, S.L. Bonanno, V.C.Nguyen, A.H. Hagedorn, T.S. Howlett, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [4] *30th Anniversary Exhibit*, N. Bajakian, J. Wong, J. DeDonato, and N. Stallings, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [5] *Venice Crowdfunding*, T. Ferrara, F de Leo, M. Bernardo and S. O'Connell, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.
- [6] *Visitor Experiences in Venice*, T. King, C. Anderson, M. Laks, and C. Hoey, WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2019.

- [7] *Venice From Above: Preserving Venetian Bell Towers*, Iuliano, C.T., Kavassalis, F.I., Colucci, N.D., Lessard, P., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [8] *Celebrating 30 Years of the Venice Project Center*, Ellis, E.J., Morton, K.J., Carpinì, N.A.D., Hale, S.A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [9] *PreserVenice Launch: A Crowdfunding Solution to Preserving Venetian Heritage*, Hetherington, B.F., Berardi, D., Thompson, K.R., Joy, S.P., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [10] *Tech Mecca in Giudecca*, McMahon, A.J., Hiscox, C.A., Maida, P.J., Lee, R.T., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [11] *Exploring Urban Permaculture: Initializing a Path to a Greener Venice*, Jordan, A.S., O'Driscoll, K.J., Manca, R. A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [12] *Open For Business: Analyzing Venetian Storefronts*, Bartone, J.R., Scales, K.J., Racca, S.R., Chen, Y., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [13] *Venice Without Obstacles*, DeRusha, A.C., Abenante, E.R., DiStefano, M.S., Jones, S.A., WPI Venice Project Center, advised by W. Michalson and F. Carrera, 2018.
- [14] *Documenting and Promoting the Impacts of the Melbourne Project Center*, Seely, C.A., Day, J.L., Cochran, I.L., and Carlson, K.A.M., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [15] *Students' Mental Wellbeing in Universities Located in Melbourne*, Isaro, A., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [16] *I See a Psychologist -- Reducing Stigma through Normalizing Mental Health Care in Australia*, Vayas, NN., Daci, E.G., and Bianco, C.E., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [17] *Improving Web Presence and Stakeholder Interaction for the Emergency Services Foundation*, Savage, H.A, Sanchy, M.T., Capozzi, R. and Babel, B.M., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [18] *Understanding Visitor Experiences at the Pauline Gandel Children's Gallery*, Nigro, J.T., France, G.T., Coppolino, J.R. and Blakslee, B.S., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [19] *A Citizen Science Platform for Long-Term Monitoring of Microplastic Pollution in Port Phillip Bay*, Bayas, A.C., Buckley, M.J., Ford, C.K. and Lawes, J.A., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [20] *A Comprehensive Methodology for Assessing the Quality of Solar Photovoltaic Systems*, Arthur, D.P., Hoey, C.J., Laffer, T. and Westgate, B., WPI Melbourne Project Center, advised by S. McCauley and W. Michalson, 2017.
- [21] *High Efficiency Power Inverter*, Grzegorz J. Klos and Robert Hall, 2015.

- [22] *An Analysis and comparison of affordable and ecological short-term transportation energy solutions*, Bryan Thomas Gleason, 2009.
- [23] *Lens and Lights Operational Overview*, Andrew Thomas Wilkins, ECE; Matthew Houstle, ECE; and Anthony R. Azersky, CS, 2009.

4.4 Graduate Theses Advised and Co-Advised

4.4.1 MS Theses (current)

- [1] Pratik Jawahar, “High-Level Exogenous Fault Detection in Multi Robot Systems with Variational Autoencoders and Normalizing Flows,” MS Thesis, co-advisor, 2022.
- [2] Rohan Walia, “Formation-Centric Software Interface,” MS Thesis, co-advisor, 2022.

4.4.2 MS Theses (completed)

- [1] Nathaniel Michaels, “A Modular Robotic AFO for detecting phase changes during Walking Gait,” MS Thesis, co-advisor, 2020.
- [2] Hernandez, A. C., “Implementing and Comparing Image Convolution Methods on an FPGA at the Register-Transfer Level,” MS Thesis, co-advisor, 2019.
- [3] Katie Gandomi, “Implementation of a Modular Software Architecture on a Real-Time Operating System for Generic Control over MRI Compatible Surgical Robots,” MS Thesis, co-advisor, 2018.
- [4] Adhavan Jayabalan, “Decentralized Persistent Connectivity Deployment in Robot Swarm,” MS Thesis, co-advisor, 2018.
- [5] Janani Mohan, “Dynamic Task Allocation in Robot Swarms with Limited Buffer and Energy Constraints,” MS Thesis, co-advisor, 2018.
- [6] Rogers, J.P., GNSS and Inertial Fused Navigation Filter Simulation, MS Thesis, co-advisor, 2018.
- [7] Christopher Bove, “Constrained Motion Planning System for MRI-Guided, Needle-Based, Robotic Interventions,” MS Thesis, co-advisor, 2018.
- [8] Vyas, Shivang, “Feature detection in an indoor environment using Hardware Accelerators for time-efficient Monocular SLAM,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 2015.
- [9] Morin, Russell, “A Novel Localization System For Experimental Autonomous Underwater Vehicles,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 2010.
- [10] Navalekar, Abhijit, “Design of an OFDM-Based VHF Modem,” MS Thesis, primary advisor, Worcester Polytechnic Institute.
- [11] Ahlehagh, Hasti, “Techniques for Communications and Geolocation Using Wireless Ad Hoc Networks,” MS Thesis, primary advisor, Worcester Polytechnic Institute, 2004.
- [12] Sebastian, Dalys, “Development of a Field-Deployable Ultrasound Scanner System,” MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.

- [13] Tobgay, Sonam, "Novel Concepts for RF Surface Coils with Integrated Receivers," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2004.
- [14] Breen, Daniel, "Characterization of Multi-Carrier Locator Performance," MS Thesis, co-advisor, 2004.
- [15] Aghogho, Obi, "A Novel Radio Frequency Coil Design for Breast Cancer Screening in a Magnetic Resonance Imaging System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 2003.
- [16] Fei, Ming, "Electromagnetic Detection, Infrared Visualization and Image Processing Techniques for Non-Metallic Inclusions in Molten Aluminum," MS Thesis, co-advisor, 2002.
- [17] Lavoie, Bruce, "Design and Implementation of an N-Channel Self Calibrating Audio System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 2000.
- [18] Bogdonov, Gene, "Theoretical and Practical Implementation of Electrical Impedance Material Inspection of Powder Metallurgy Compacts," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1999.
- [19] Messier, Andrew, "Modeling the Effects of Terrain Masking on GPS Accuracy and Integrity," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1998.
- [20] Antonescu, Bogdan, "Elliptic Curve Cryptosystems on Embedded Microprocessors," Bogdan Antonescu, MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [21] Lai, Qiang, "Ground-Penetrating Radar Data Processing System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [22] Soria-Rodríguez, Pedro, "Multicast-Based Interactive-Group Object-Replication For Fault Tolerance," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1998.
- [23] Hoy, William, "Audio Signal Denoising Using Wavelets," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.
- [24] Proгри, Ilir, "Harmonic Flow Monitoring by means of Global Positioning System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1997.
- [25] Bretchko, Pavel, "Pulsed Hysteresis Graph System," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.
- [26] Repkin, Dmitry V., "A Hierarchical Neural Network Based Data Processing System for Ground Penetrating Radar," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1997.
- [27] Metsis, Sophocles, "Design of a Real-Time Capable, Fault-Tolerant, Distributed System," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.
- [28] Hill, Jonathan, "Efficient Implementation of Mesh Generation and FDTD Simulation of Electromagnetic Fields," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1996.
- [29] Dunkelberg, John, "FEM Mesh Mapping to a SIMD Machine Using Genetic Algorithms," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1996.

- [30] Leuenberger, Georg, "Design and Development of a Microprocessor Based Gauss Meter," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1995.
- [31] Valentino, Ralph, "DISC: A Dynamic Instruction Set Coprocessor," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1995.
- [32] Muley, Aalok, "A Fault Tolerant Network for a Real-Time Environment," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1994.
- [33] Mohan, Surrender, "Automatic Surface Mesh Generation for 3D Solid Models Using Delaunay Algorithm," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.
- [34] Petrangelo, John, "Experimental Preconditioners for Large Dense Systems," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1994.
- [35] Schneider, Eric, "Design, Simulation, and Analysis of a 3D Integrated Optical Computer," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1993.
- [36] Palmer, Bradley, "A Comparison of Three Protocols Supporting Time-Dependent and Time-Independent Communications," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [37] Clayton, Shawn, "An Analysis of the Real-Time Behavior of Galactica Net," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [38] Levergood, Thomas, "An Experimental Evaluation of Split User/Supervisor Cache Memories," MS Thesis, primary advisor, Worcester Polytechnic Institute, 1992.
- [39] Lavalee, James, "The Design and Development of Real-Time Systems Using Ada and the Activation Framework," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.
- [40] Velazques, Javier, "The Development of a Real-Time Environment Using the Activation Framework," MS Thesis, co-advisor, Worcester Polytechnic Institute, 1992.

4.4.3 Ph. D. Dissertations (current)

- [1] Vincenzo Diluoffo, "Security in the Robot Operating System Version 2 (ROS 2) Environment," primary advisor.
- [2] Jitesh, "Ad-Hoc Networking for Bandwidth Limited LMR Systems," primary advisor.

4.4.4 Ph. D. Dissertations (completed)

- [1] Carvalho, P. A., "Advancing Technologies for Interventional MRI Robotics with Clinical Applications," 2019.
- [2] Ferreira, PVR "SRML: Space Radio Machine Learning," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2017.
- [3] Iyer, Vishwanath, "Broadband Impedance Matching of Antenna Radiators," Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2010.
- [4] Navalekar, Abhijit, "Distributed Digital Radios For Land Mobile Radio Applications," Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2009.

- [5] Parikh, Hemish, “Design of an OFDM Transmitter and Receiver for Precision Personnel Location,” primary advisor.
- [6] Proгри, Ilir, “An Assessment of Indoor Geolocation Systems,” Ph.D. Dissertation, primary advisor, Worcester Polytechnic Institute, 2003.
- [7] Li, Xinrong, “Super-Resolution TOA Estimation with Diversity Techniques for Indoor Applications,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.
- [8] Leuenberger, Gerog H. W., “Electrostatic Density Measurements in Green-State PM Parts,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2003.
- [9] Bogdanov, Gene, “Radio-Frequency Coil Design for High Field Magnetic Resonance Imaging,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.
- [10] Elbirt, Adam J., “Reconfigurable Computing for Symmetric-Key Algorithms,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2002.
- [11] Bretchko, Pavel, “Design and Development of Ultra-wideband DC-Coupled Amplifier,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 2001.
- [12] Hill, Jonathan, “Development of an Experimental Global Positioning System (GPS) Receiver Platform for Navigation Algorithm Evaluation,” Ph.D. Dissertation, primary advisor, 2001.
- [13] Spasojević, Mirko, “Creation of Sparse Boundary Element Matricies for 2-D and Axi-symmetric Electrostatic Problems Using a Bi-orthogonal Wavelet,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1997.
- [14] Shi, Funan, “Optimal Designs of Gradient and RF Coils for Magnetic Resonance Imaging (MRI) Instrument,” Ph.D. Dissertation, co-advisor, Worcester Polytechnic Institute, 1996.

5. Proposals and Funding:

5.1 Funding Received

\$300,000	MRI: Development of an autonomous, Connected and Data-Driven Vehicle for Multi-Disciplinary Research, Co-PI, 09/13/16.
\$200,000	Advanced Bayesian Methods for Autonomous Navigation, Co-PI, 07/25/11.
\$50,524	PCOG Broadband Modem, PI, \$50,524, 05/15/09.
\$839,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 09/06/07.
\$83,726	State Communications Interoperability, PI, 07/18/07.
\$224,822	MANET Protocols for Capacity-Limited Channels, PI, 03/08/07.
\$44,366	TATRC: Wireless Sensor Communications, Co-PI, 12/20/06.
\$95,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 02/13/06.
\$3,225,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 12/19/05.
\$1,973,286	Precision Indoor/Outdoor Personnel Locator, Co-PI, 09/23/05.

\$25,000	Sensor-on-a-Chip for Electrophysiological Monitoring, Co-PI, 08/08/05.
\$1,245,000	Real-Time Troop Physiological Status Monitoring System, Co-PI, 12/23/04.
\$1,370	WPI-NanoSAT Program, Co-PI, 11/03/04.
\$37,408	Precision Indoor/Outdoor Personnel Locator, Co-PI, 10/05/04.
\$74,048	Real-Time Troop Physiological Status Monitoring System, PI, 09/15/04.
\$813,141	Real-Time Troop Physiological Status Monitoring System, PI, 12/08/03.
\$255,496	Precision Indoor/Outdoor Personnel Locator, Co-PI, 10/31/03.
\$3,246	WPI-NanoSAT Program, Co-PI, 10/20/03.
\$2,789	WPI-NanoSAT Program, Co-PI, 03/06/03.
\$827,000	Real-Time Troop Physiological Status Monitoring System, PI, 11/22/02.
\$14,866	Norfolk County Sheriff's Office Data Mining, Co-PI, 02/01/02.
\$54,483	Auto-calibrating surround sound system, PI, 2001.
\$11,252	Auto-calibrating surround sound system, PI, 2000.
\$18,977	GPS-Based Attitude Determination System, PI, 07/1998.
\$70,000	Development of an Electric Resistivity Instrument for the Testing of Green-State P/M Compacts, Co-PI, 01/1997.
\$10,550	GPS Hazard Detection, Co-PI, 1996.
\$200,000	Integrity for the Global Positioning System - Supplemental Funding I, Co-PI, 1995.
\$3,000	GPS-Based Tracking of Forest Vehicles, PI, 1995.
\$7,200	Acoustic Identification of Mosquito Species, Co-PI, 1995.
\$9,978	Acoustic Identification of Mosquito Species, Co-PI, 1995.
\$11,527	Laboratory Equipment for Microkernel Based Embedded Systems, Co-PI, 1995.
\$74,388	RF Circuit and Antenna Modeling on High Performance Computers, Co- PI, 1994.
\$199,075	Integrity for the Global Positioning system, PI, 1994.
\$326,336	3D Modeling of Microwave Antennas on High-Performance Parallel Computers, Co-PI, 1993.
\$338, 687	Integrity for the Global Positioning system, Co-PI, 1993.

6. Honors, Awards, and Recognitions:

Elected Senior Member of the IEEE.

Joseph Samuel Satin Distinguished Fellowship awarded for the 1994-1995 academic year.

Aldo Miccioli Fellowship recipient from Raytheon Equipment Division.

ION Best Paper Award - GPS-96 for W. R. Michalson, W. Cidela, et. al., “A GPS-Based Hazard Detection and Warning System,” in review, " *ION GPS-96, 9th International Meeting of the Satellite Division of the Institute of Navigation*, pp. 167-175, Kansas City, MO, Sep 17-20, 1996

2nd Place - 2004 ECE Department MQP Award / Provost's MQP Award for *GPS-Based Orbit and Attitude Determination System for PANSAT*, Joshua Holwell, Andrew Coonradt and Himanshu Agrawal.

1st Place - 2003 ECE Department MQP Award / Provost's MQP Award for *Personal Inertial Navigation System*, Jason DeChiaro and Chris Struus.

1st Place - 2002 ECE Department MQP Award / Provost's MQP Award for *Handspring Digital Voltmeter*, Andrew Young and Pavel Loven.

3rd Place - 1998 ECE Department MQP Award / Provost's MQP Award for *Design of a Personal Handheld GPS Receiver*, Jeffery Alderson and Helder Machado.

2nd Place - 1997 ECE Department MQP Award / Provost's MQP Award for *Distributed Audio Controller*, EE-WZM-1B96, Stephen S. Richardson.

3rd Place - 1997 ECE Department MQP Award / Provost's MQP Award for *GPS Hazard Detector II*, EE-WZM-2A96, Will Brothers, Jon Day, and John Zaghi.

1st Place - 1996 ECE Department MQP Award / Provost's MQP Award for *GPS Hazard Detector*, EE-WHE-9601, Michael Roberts, William Cidela, and Chris Mangiarelli.

6.1 Memberships and offices held in professional society

- Institute of Electrical and Electronic Engineers, Senior Member
- Institute of Navigation
- Royal Institute of Navigation
- American Society of Engineering Educators
- National Academy of Inventors
- Society of Automotive Engineers

6.2 Professional Service

Massachusetts Board of Bar Overseers Hearing Committee Member, 2010-Present.

Steering Committee – 2009 First Annual Robotics Innovations Competition and Conference (RICC '09), Nov 7-8, Worcester, MA, 2009.

Conference Technical Co-Chair – 2009 IEEE International Conference on Technologies of Practical Robot Applications (TePRA 2009), Nov. 9-11, Woburn, MA, 2009.

Reviewer – Proposal number CRDPJ 379622-08, Natural Sciences and Engineering Research Council of Canada (NSERC), Mar. 2009

Co-Chair – Urban and Indoor Geolocation, Institute of Navigation International Technical Meeting (ITM2009), Anaheim CA, Jan. 2009.

Reviewer – Proposal number CRDPJ 379622-08, Natural Sciences and Engineering Research Council of Canada (NSERC), Mar. 2009