

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Andrew William Wright
U.S. Patent No.: 9,633,487 Attorney Docket No.: 36137-0025IP1
Issue Date: April 25, 2017
Appl. Serial No.: 15/061,910
Filing Date: March 4, 2016
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: 16 March 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 9,633,487 (“the ’487 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 ’487 patent.

2. I have been asked to provide my independent analysis of the ’487 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 ’487 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 ’487 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 Electrical Engineering from the Worcester Polytechnic Institute (WPI) in 1985 and 1989, respectively.

6. I am currently a tenured Professor in Robotics Engineering in the Robotics Engineering Department of WPI. Additionally, I have appointments as a Professor of Computer Science, Electrical and Computer Engineering, and Mechanical Engineering. 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 communication and navigation 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, 2, 5, 9, and 11-13 of the '487 patent are made obvious by Curry and Rabu
- **Ground 1B:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 3 and 4 of the '487 patent are made obvious by Curry, Rabu, and Balachandran
- **Ground 1C:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 6-8 of the '487 patent are made obvious by Curry, Rabu, and Katayama

- **Ground 1D:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claim 10 of the '487 patent is made obvious by Curry, Rabu and Tamir
- **Ground 2A:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 1, 2, 12, and 13 of the '487 patent are made obvious by Forstall, Rabu, and Langle2009
- **Ground 2B:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 3 and 4 of the '487 patent are made obvious by Forstall, Rabu, Langle2009, and Balachandran
- **Ground 2C:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 6-8 of the '487 patent are made obvious by Forstall, Rabu, Langle2009, and Katayama
- **Ground 2D:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 5, 9, and 11 of the '487 patent are made obvious by Forstall, Rabu, Langle2009, and Warren

- **Ground 2E:** Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claim 10 of the '487 patent is made obvious by Forstall, Rabu, Langle2009, and Tamir

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 '487 patent was filed March 4, 2016, 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 '487 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 '487 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 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). More

education, e.g., 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 declaration. 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 '487 patent; my own knowledge and experiences gained from my work experience in the field of the '487 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. 9,633,487 to Wright (“the '487 Patent”) (USAA-1001)
- Excerpts from the Prosecution History of the '487 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 (“Cheng2010”) (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: 131-136 (“Hunt”) (USAA-1020)
- Kanianthra, Joseph, Arthur Carter, and Gerard Preziotti, “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 (2002) (“Farris2002”) (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, 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)
- 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 2010/06899 (“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)

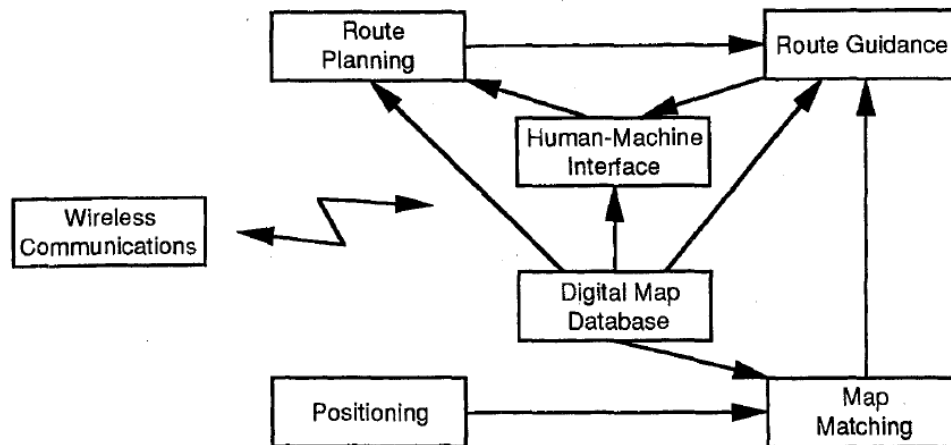
- Schäfer, Ralf-Peter, et al., “A traffic information system by means of real-time floating-car data” (2002) (“Schäfer2002”) (USAA-1061)
- Kerner, B. S., et al., “Traffic state detection with floating car data in road networks,” Proceedings of the 8th International IEEE Conference on Intelligent Transportation 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.

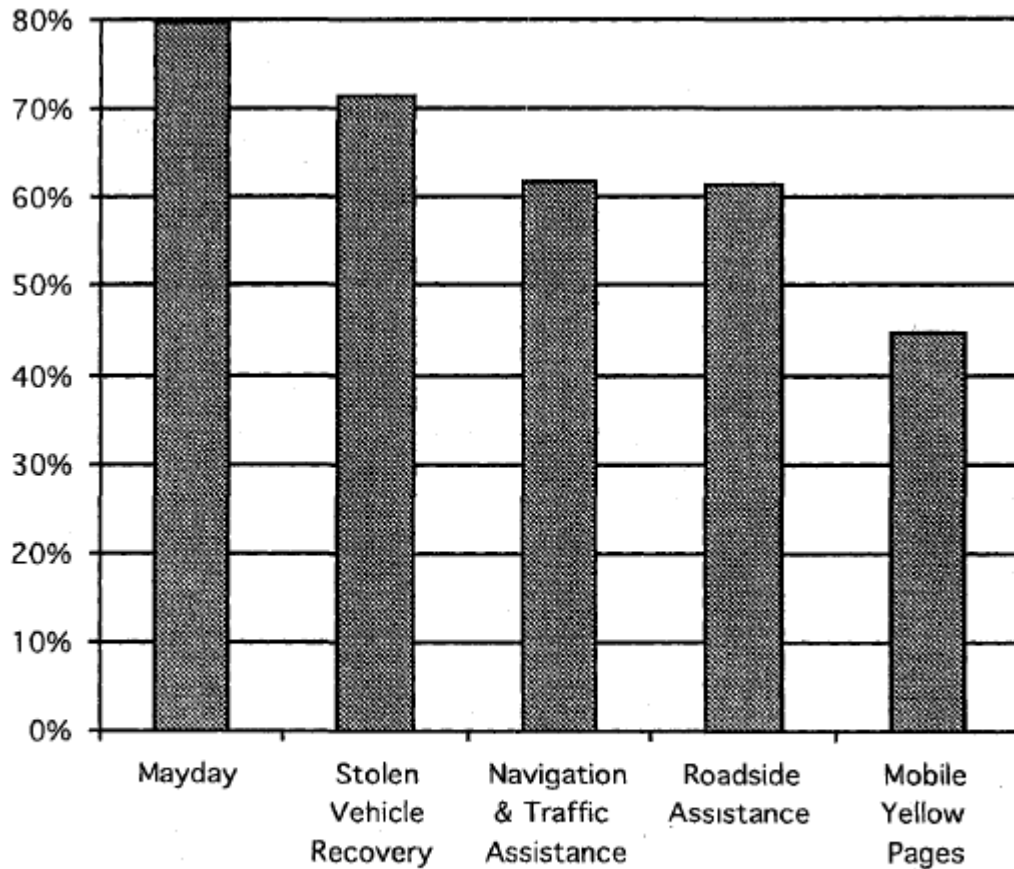


Figure 1.5 American consumer interest in location-based mobile services.

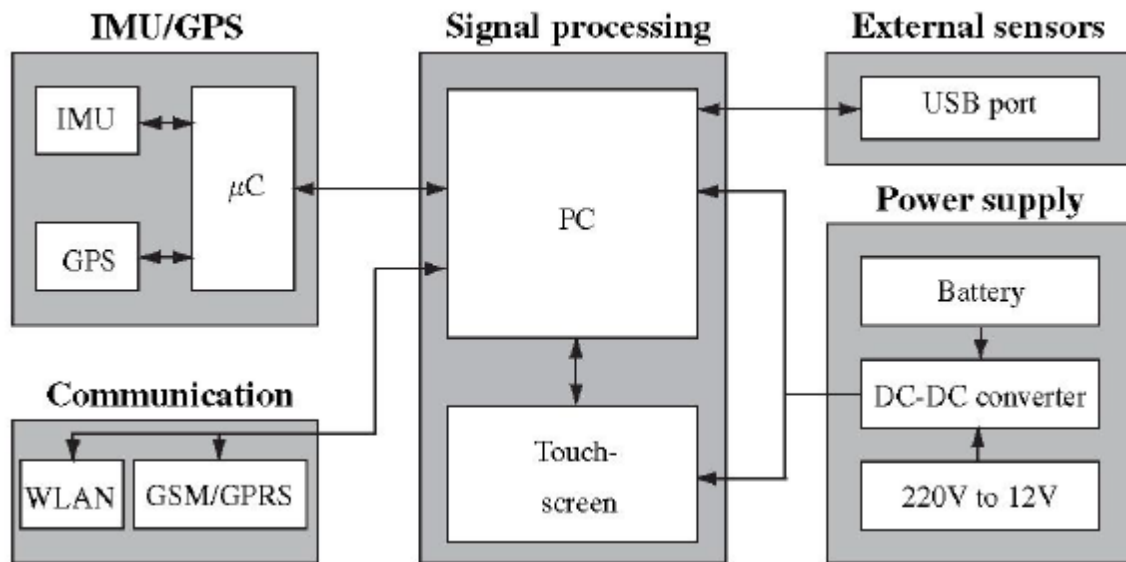
USAA-1046, 25

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 the Skog2006 system is analogous to the '487 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 '487 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 '487 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 '487 patent. By 2008, the literature often referred to mobile devices as “smartphones” and these devices included all of the sensing features described in the '487 Patent. USAA-1049, 1. Work2008 is one example that included the following description:

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

37. The '487 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.

38. 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.

39. 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*

40. The ’487 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 necessary 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.

41. 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*

42. The '487 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.

43. 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*

44. One of the sensors identified in the '487 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 ’487 patent admits that such positioning modules were already known in the art.

45. 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.

46. 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*

47. The '487 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.

48. 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*

49. The '487 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.

50. The use of orientation sensors in mobile devices was 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

51. 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

52. 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

53. 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

54. 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, 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 '487 PATENT

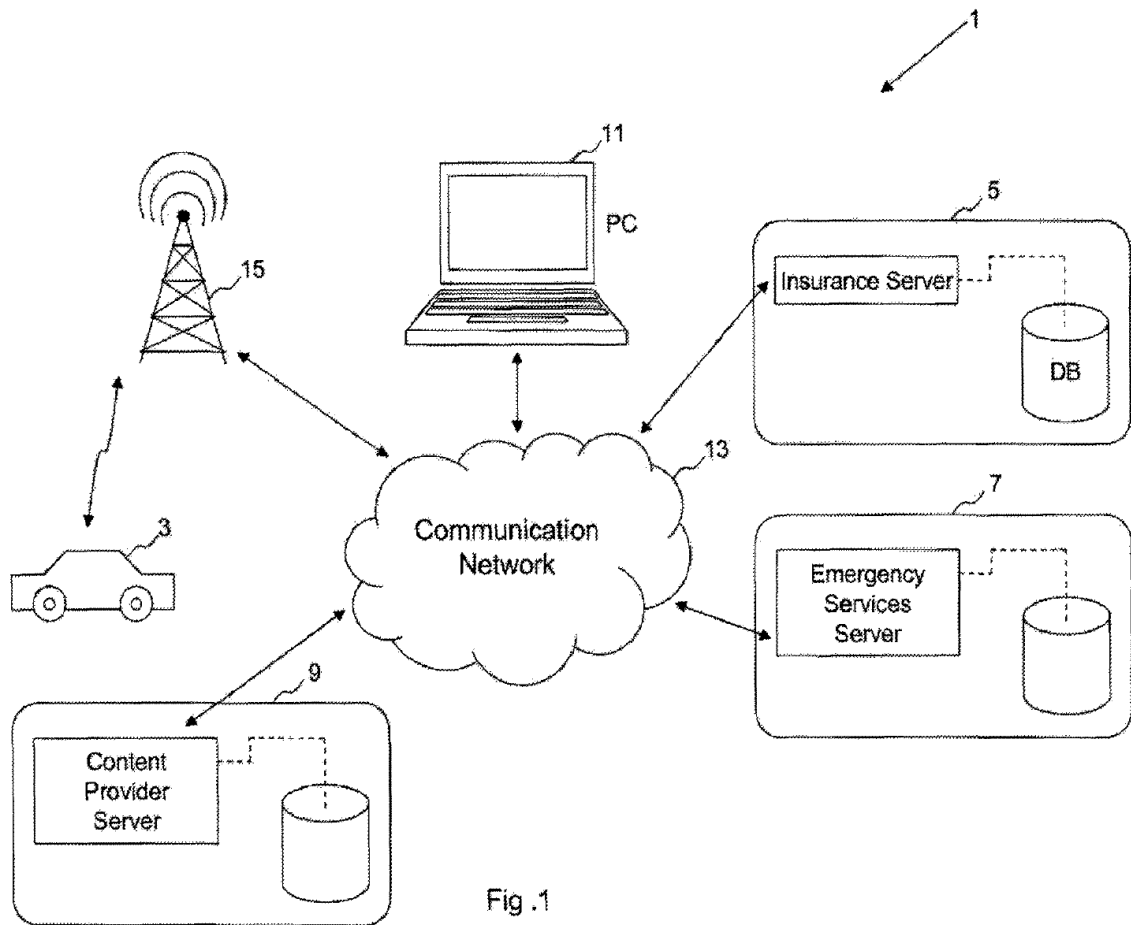
A. Specification

55. The '487 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.*, 1:19-27. The driving information can be used to “determine the cause of an accident,” “modify driver behaviour” or “determine insurance premiums.” *Id.* While the '487 patent states 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.*, 1:46-55. This is consistent with the existence of several well-known vehicle monitoring technologies that were conventional by the Critical Date.

56. Various embodiments described in the '487 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, 1:61-2:11. 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 ’487 patent specification as the “‘Witness’ application.” *See, e.g., id.*, 13:54-60, 23:14-24:64.

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



USAA-1001, Fig. 1

58. System 1 includes “a mobile telecommunications device executing the Witness application...” USAA-1001, 13:15-32. 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.*, 13:33-53. 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

59. The table below includes identifiers for the ’487 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]	the mobile telecommunications device configured to: determine, based on 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;
	[1.8]	store a selection of the driving information to the memory;
	[1.9]	wherein the driving information is derived without data from vehicle sensors, and
	[1.10]	the mobile telecommunications device is controlled by a downloaded application to control the mobile device to detect occurrence of a predetermined event and in response take at least one predetermined action.
2	[2]	The mobile telecommunication device according to claim 1, wherein the predetermined action is storing driving information associated with that event to the memory.
3	[3.1]	The mobile telecommunications device according to claim 1, wherein the predetermined action comprises providing feedback to a user to indicate that an event

Claim	Identifier	Claim Language
		has been detected,
	[3.2]	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.
4	[4.1]	The mobile telecommunications device according to claim 3, wherein the feedback comprises notifying a user that a further action has been scheduled, and will be taken within a predetermined period,
	[4.2]	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.
5	[5.1]	A mobile telecommunications device according to claim 1, wherein the predetermined action comprises communicating to a remote system that an event has been detected,
	[5.2]	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.
6	[6.1]	The mobile telecommunications device according to claim 1, wherein the memory comprises: a long term memory for persistently storing driving information and a short term memory for transiently storing driving information,
	[6.2]	wherein the short term memory receives driving information at a higher update rate than the long term memory,
	[6.3]	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,
	[6.4]	overwrite the driving information previously written to

Claim	Identifier	Claim Language
		the short term memory in accordance with the predetermined sequence.
7	[7.1]	The mobile telecommunications device according to claim 6, wherein the mobile communications device is controlled by the downloaded application to control the mobile device to detect an occurrence of a predetermined event and
	[7.2]	in response transfer data from the short term memory to the long term memory.
8	[8.1]	The 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,
	[8.2]	to receive at least a portion of the external driving information from the external device.
9	[9.0]	The mobile telecommunications device according to claim 1, wherein the mobile communications device is controlled by the downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.
10	[10.0]	The mobile telecommunication device according to claim 1, wherein the predetermined action is storing driving information captured at a higher sampling rate than when an event is not detected.
11	[11]	The mobile telecommunication device according to claim 1, wherein the predetermined action is transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system.
12	[12]	The mobile telecommunication device according to claim 11, wherein the mobile telecommunications device utilizes its own power supply.

Claim	Identifier	Claim Language
13	[13]	The mobile telecommunication device according to claim 11, wherein the mobile telecommunications device is a smartphone.

C. Prosecution History

60. During prosecution of the '487 patent, the examiner rejected the claims over U.S. Pub. Nos. 2007/0135979 (“Plante”), 2005/0046584 (“Breed”), and 2008/0255722 (“McClellan”). *See* USAA-1002, 40-50.

61. Specifically, the patent examiner issued a Non-Final Office Action on November 10, 2016. *Id.* The Non-Final Office Action rejected claims 9-11, and 13-16 under 35 U.S.C. § 102 over Plante. *Id.*, 40-46. The Non-Final Office Action also rejected claim 12 under 35 U.S.C. § 103 over Plante in view Breed (*id.*, 47) and claim 17 under 35 U.S.C. § 103 over Plante in view of McClellan (*id.*, 48).

62. Applicant filed a Reply to Non-Final Office Action on December 16, 2016. *Id.*, 26-37. The Reply amended several claims in response to the rejections cited in the Non-Final Office Action. For example, the Reply amended claim 9 to add the features of “[a] mobile telecommunications device configured to: determine, based on 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[.]” *Id.*, 27. The Reply

also added the new feature that “the driving information is derived without data from vehicle sensors[.]” to claim 9. *Id.*

63. The Reply included arguments attempting to distinguish the Plante reference. *See id.*, 31-37. The Reply explained that “the claims are now directed to a mobile telecommunications device which is controlled by a downloaded application and the driving information that it derives is from processing the sensor data on the mobile device without obtaining data from vehicle sensors[.]” and that “[t]his is contrary to what is disclosed in Plante.” *Id.*, 31. The Reply further explained that “[t]he advantages of having a mobile device that is not reliant on the vehicle are clear[.]” and that “[n]ot only does this mean that the data recording can be made personal by recording the driving of a user in different vehicles to be captured and analyzed, but also the retrofitting of older vehicles with mobile devices in accordance with Plante (which is expensive) can be avoided.” *Id.*, 33-34.

64. The patent examiner issued a Notice of Allowance on February 28, 2017. *Id.*, 8-15. The Notice of Allowance stated that the references of record did not teach or suggest “a mobile telecommunications device, a user interface, determine, based on 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, and wherein the driving

information is derived without data from vehicle sensors, and the mobile telecommunications device is controlled by a downloaded application to controlled mobile device to detect occurrence of a predetermined event and in response take at least one predetermined action.” *Id.*, 13.

65. Based on my review of the prosecution history, the examiner did not consider any of Curry, Rabu, Balachandran, Katayama, Tamir, Forstall, Langle2009, and Warren, which, as explained in this declaration, make the Challenged Claims obvious.

IX. INTERPRETATION OF THE '487 PATENT CLAIMS

66. 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 '487 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 Curry

67. Curry is an October 2010 international patent publication that describes using a “mobile wireless computing device” with embedded accelerometers and/or positioning sensors (e.g., an “iPhone 3G smart phone[]”) to “detect and prevent unsafe driving behavior[s]”, and generate related “driving safety...score[s]” that can be used to determine insurance premiums. USAA-1005, Abstract, 2:1-27, 3:24-3:6, 4:7-11, 7:5-22, 9:31-33, Fig. 1.

68. Figure 1 (reproduced below) illustrates an exemplary system including a centrally managed driving safety data server 104 in wireless communication with a “mobile phone” 106, which “can include any type of electronic mobile computing device that may be used while traveling in a vehicle.” USAA-1005, 7:23-29, 8:21-27. A client application 110, which can be downloaded “from the server 104 to the mobile phone,” enables the phone to determine, based on “location, speed, and acceleration data from” an embedded “GPS sensor 114 and accelerometer 116” whether the vehicle is being driven, and to process “raw

data” from a driving period to derive information associated with a user’s driving behavior, including whether the phone is being used while driving, and whether the user engages in behaviors such as “speeding, abnormal acceleration, abnormal deceleration, and taking sharp turns.” USAA-1005, 7:5-22, 9:5-11, 8:30-9:33.

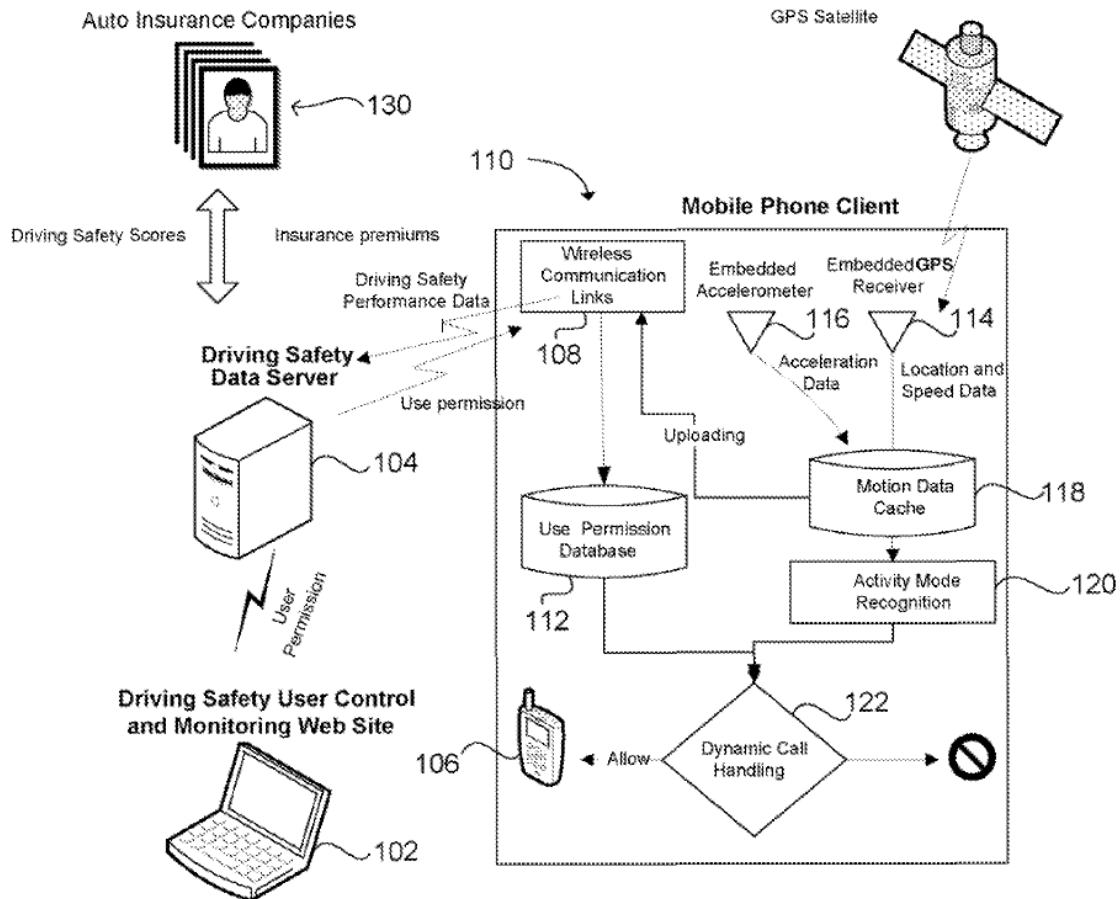


FIG. 1

USAA-1005, Fig. 1

69. Raw data and derived driving behavior information is stored in mobile phone 106 (e.g., in a “motion data cache 118” and a “driving safety performance

database 324”), and mobile client 110 processes stored information both to determine a mode within which the mobile phone should operate (e.g., “a GPS monitoring/navigation mode” or “a communication mode”), and to generate a “driving safety score” for the user that can be wirelessly communicated to third parties. *Id.*, Abstract, 3:1-4:6, 8:29-11:18, 13:27-1:26, 17:1-18:4, Figs. 1, 3, 6.

2. *Overview of Rabu*

70. 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., a “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.

71. 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-1013, 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. The “orientation” angle is therefore leveraged to confirm whether the PMD is coupled to dock 200 and to switch to an associated mode of operation. *Id.*

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, 3:29-4:4, 8:13-24, Figs. 2, 7.

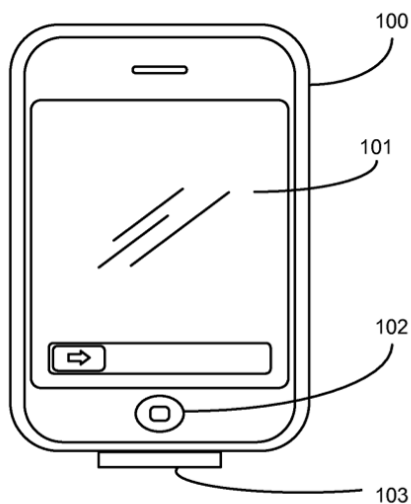


FIG. 1

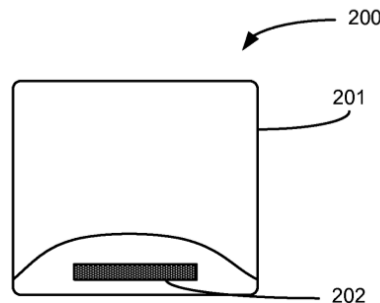


FIG. 2

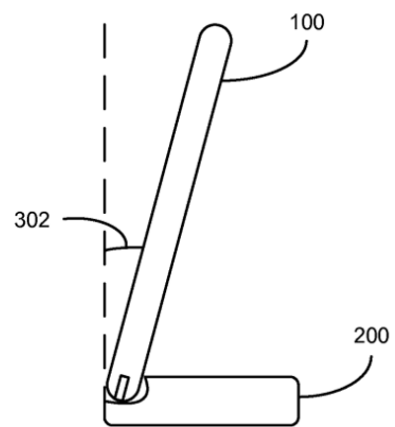
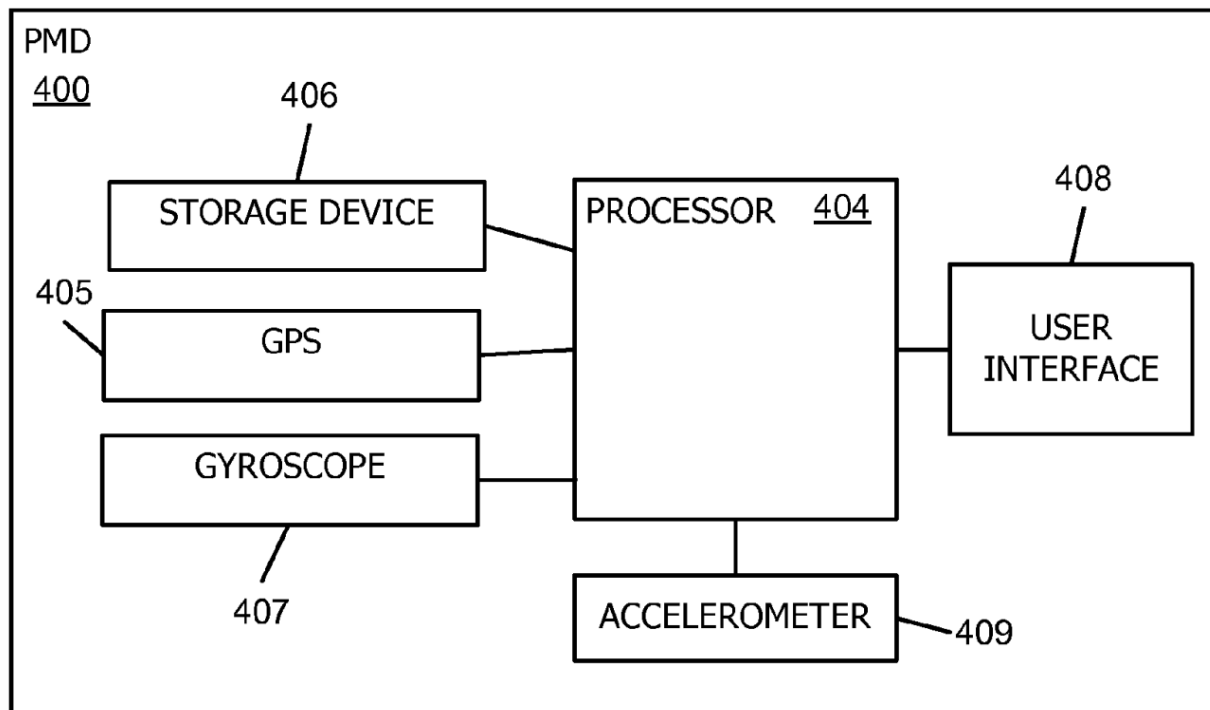


FIG. 3

USAA-1013, Fig. 1

72. As shown in Fig. 4 (reproduced 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

73. 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.

74. 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. The processor also adjusts PMD’s mode of operation based on the determined status, as shown in Figures 7 and 8 (reproduced below). 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.

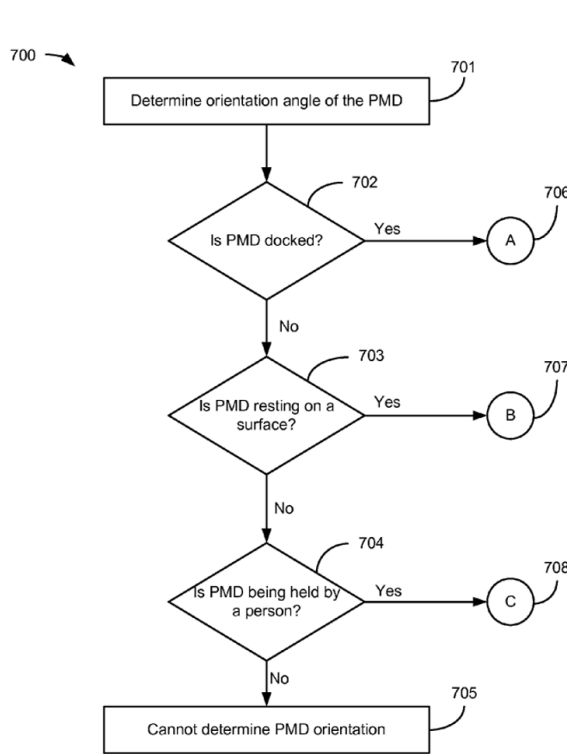


FIG. 7

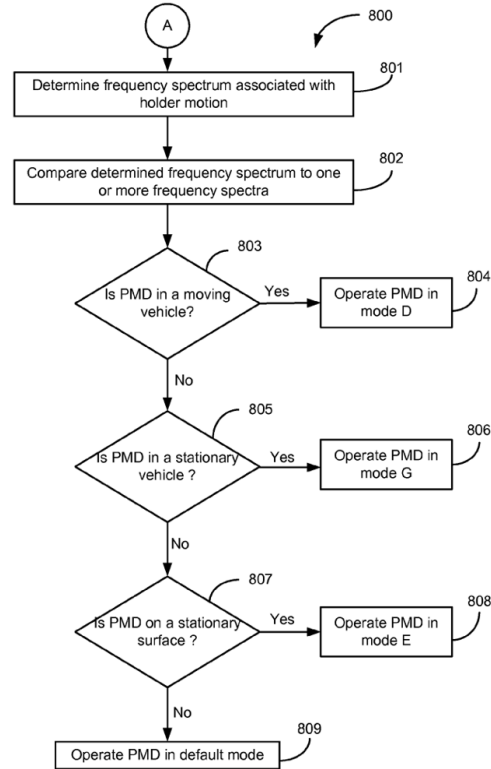


FIG. 8

USAA-1013, Figs. 7, 8

3. Overview of Balachandran

75. 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.

4. *Overview of Katayama*

76. Katayama is a European patent application publication generally focused on a “driving recorder that records behavior, a surrounding situation or the like of a motor vehicle during a certain period before and after a time of an accident...” USAA-1024, [0001]. The driving recorder can “prevent an accident by making [an] after-the-fact analysis on an ordinary driving or collect an objective evidence of a cause of the accident when the accident occurs.” *Id.*, [0002]. Figure shows a perspective view of driving recorder 1.

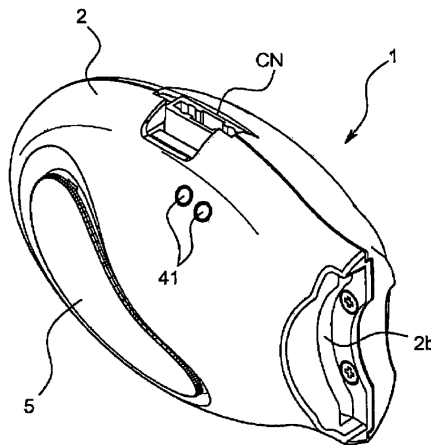


Fig.2

USAA-1024, Fig. 2

77. Recorder 1 detects occurrence of an accident based on multiple data sources, 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, door open/close data indicating whether a door is open or closed...” USAA-1024, [0013]. Figure 4 shows components of recorder 1 that collects and/or processes data from these data sources.

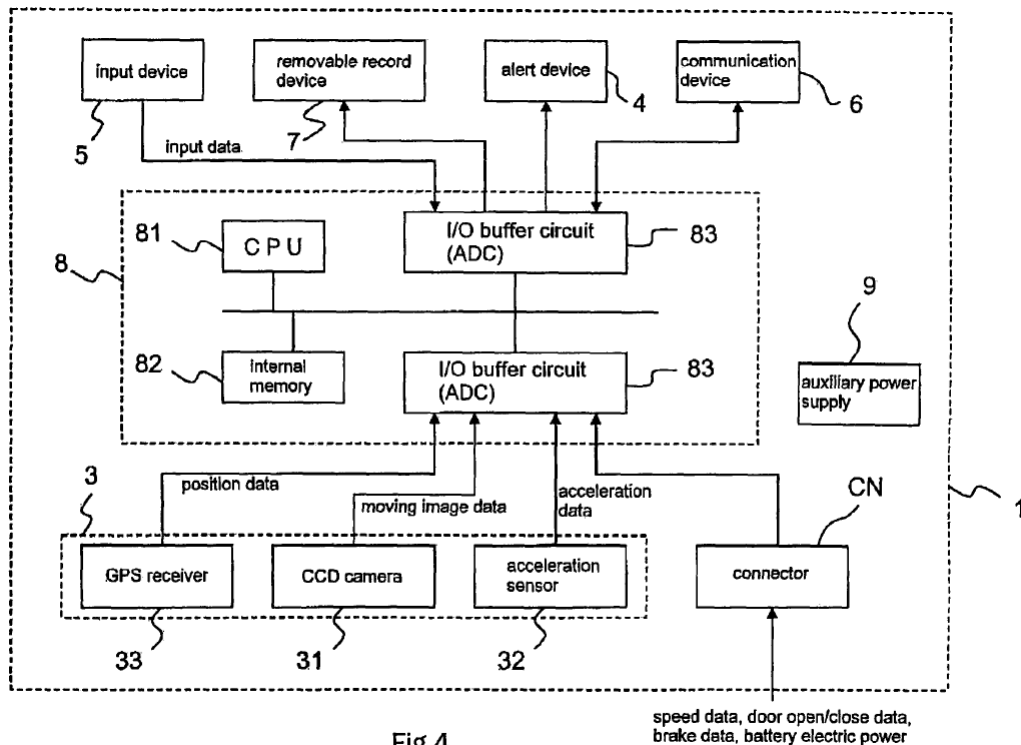


Fig.4

USAA-1024, Fig. 4

78. Recorder 1 includes detection device 3, which “senses the behavior, the surrounding situation, the operating condition or the like of [a] motor vehicle V

and outputs situation data...” USAA-1024, [0034]. Detection device 3 further includes CCD camera 31, acceleration sensor 32, and GPS receiver 33. *Id.*

Recorder 1 also includes information processing device 8 with internal memory 82 for storing programs executed by CPU 81. *Id.*, [0044]. Figure 5 shows subcomponents of information processing device 8.

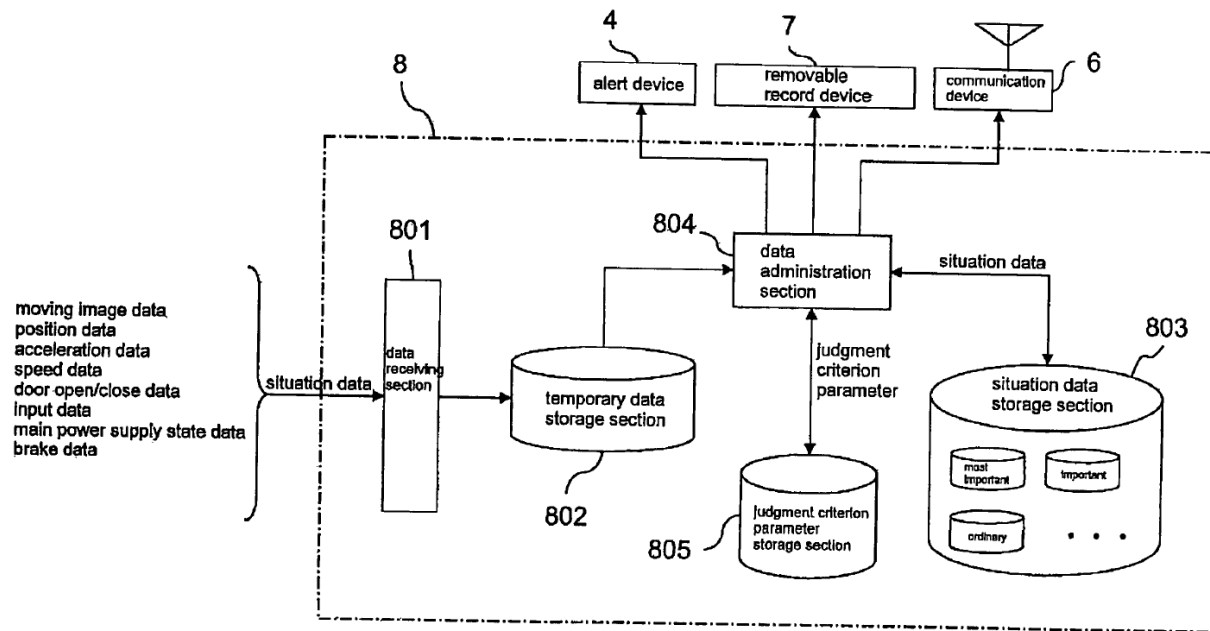


Fig.5

USAA-1024, Fig. 5

79. Information processing device 8 includes data receiving section 801, temporary storage section 802, situation data storage selection 803, data administration section 804, and judgement criterion parameter storage section 805. USAA-1024, [0044]. Data receiving section 801 “receives [] situation data as being data concerning the behavior, the surrounding situation or the link of the

motor vehicle V at a constant sampling time one after another in a chronological order and writes the situation data...in the temporary data storage section 802...”

Id. Data administration section 804 “determines whether or not the content of the situation data stored in the temporary data storage section 802 meets the predetermined condition,” and if so, the situation data is “transferred from the temporary data storage section 802 to the situation data recording section 803.”

Id., [0046].

5. *Overview of Tamir*

80. 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 a 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.

B. Ground 2

1. Overview of Forstall

81. Forstall is a January 2009 patent publication that generally 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.

82. Figure 1 shows an example of a mobile device 100 used for vehicle navigation.

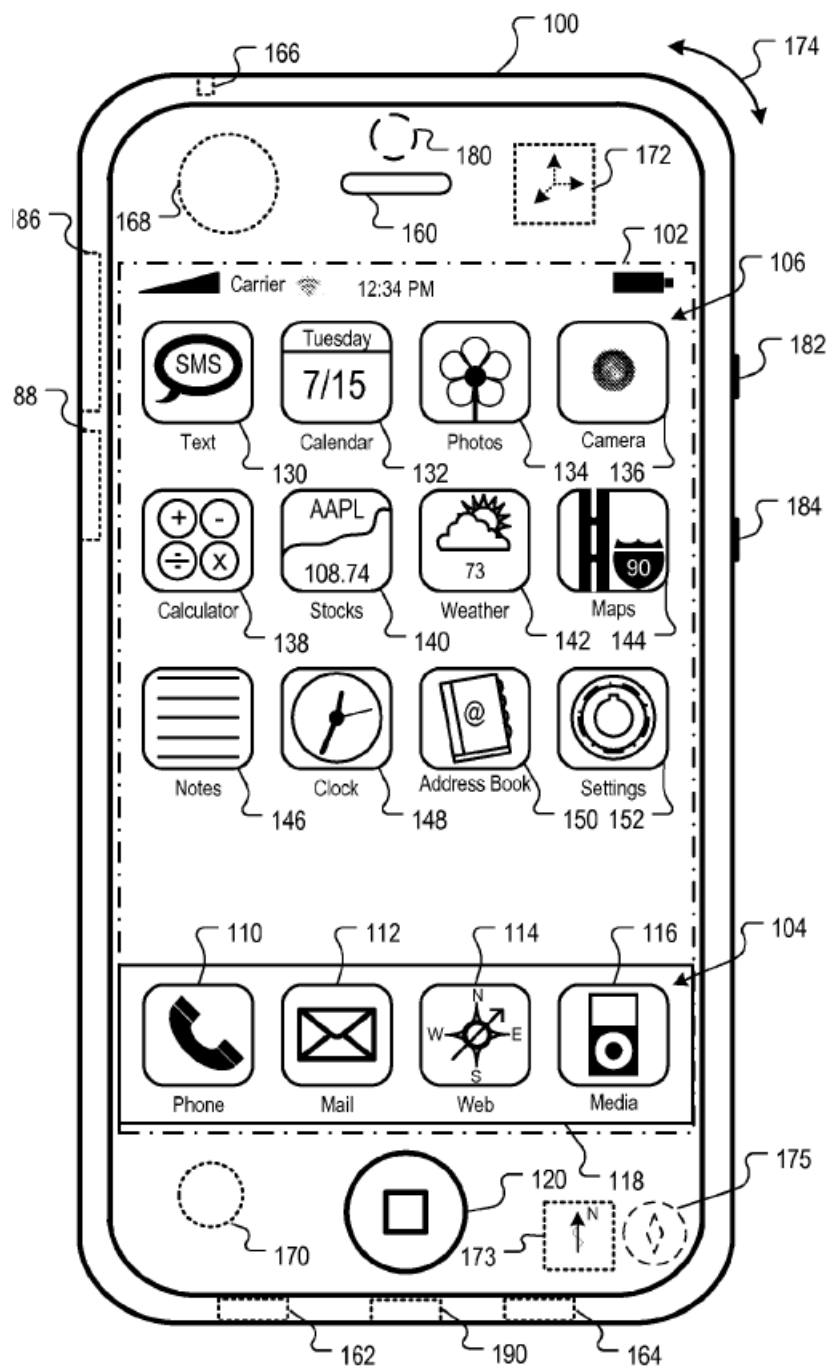


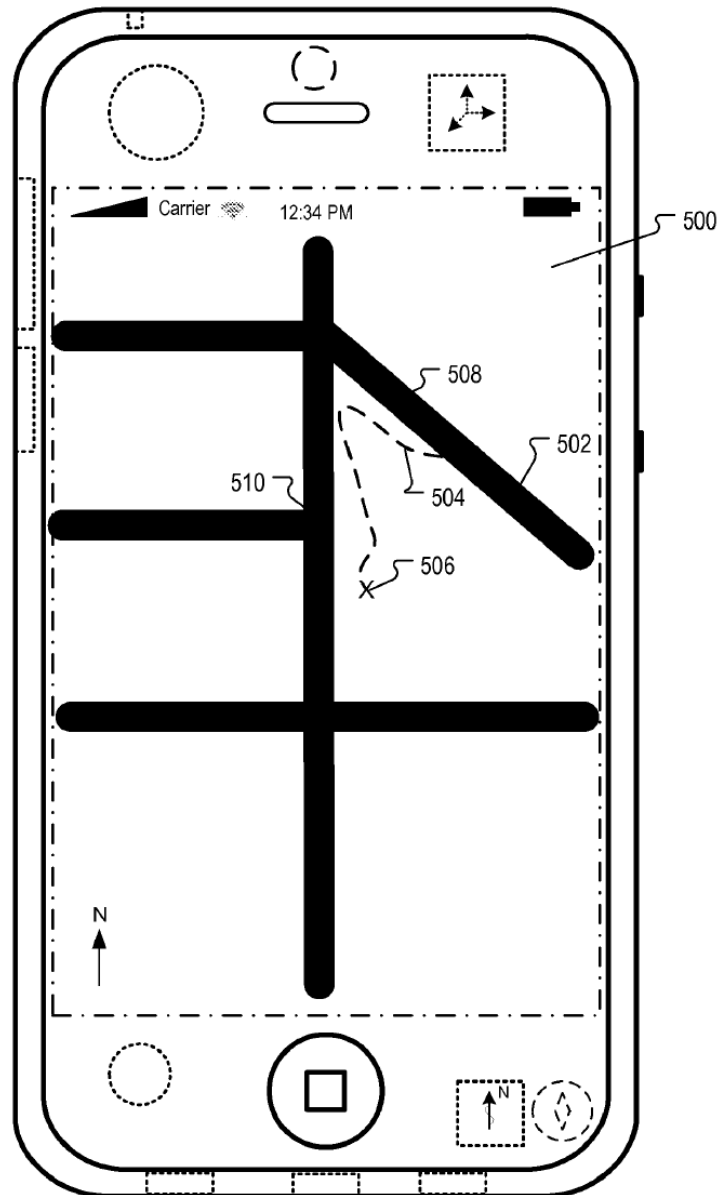
FIG. 1

USAA-1028, Fig. 1

83. 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].

84. 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, a user device “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].

85. 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

86. 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].

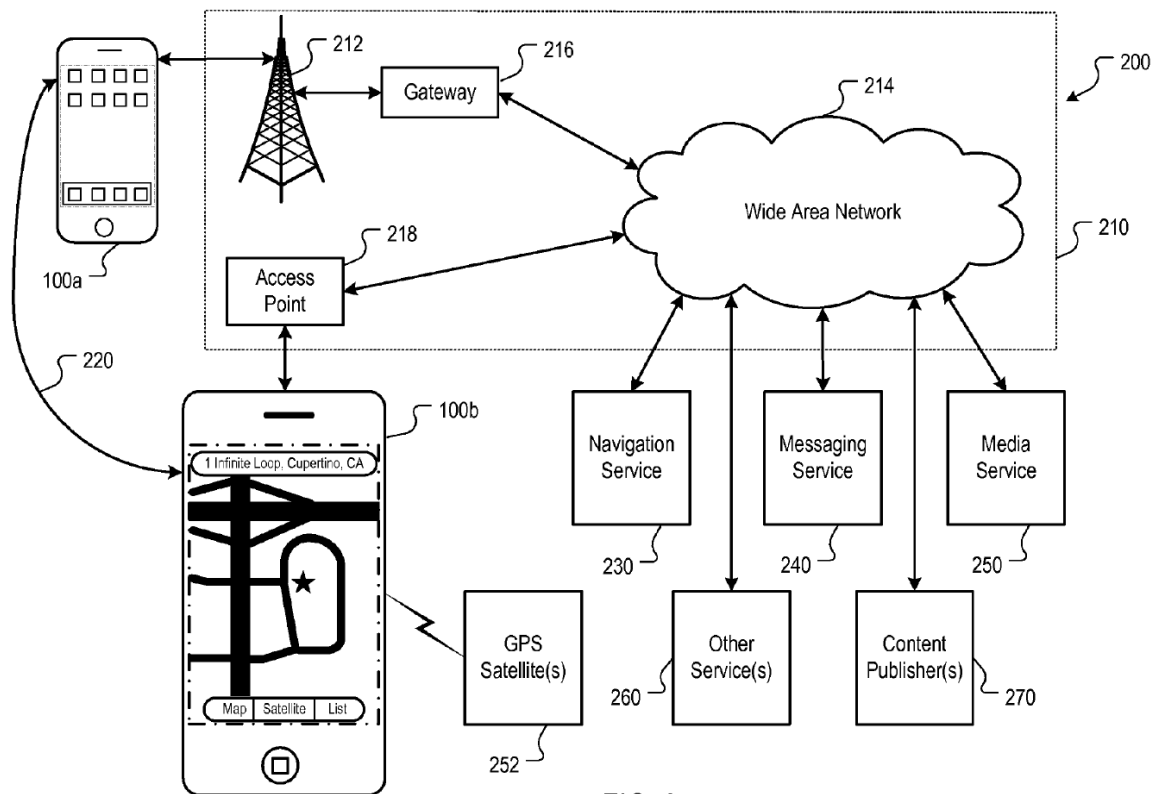


FIG. 2

USAA-1028, Fig. 2

87. 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 in which 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].

88. 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].

89. 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.*

90. 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 Langle2009*

91. Langle2009 is a conference publication focused on using mobile devices to “aid in safe driving practices and detection of emergencies.” USAA-1029, 1. Langle2009 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 “[braking] distance, acceleration, and deceleration...” *Id.*

92. Langle2009 recognizes that mobile phones include “embedded accelerometers” that are “used for risk level detection while riding in a vehicle.” USAA-1029, 1. It also states that “[p]rogramming with accelerometers on the Android platform is straightforward and supports three axes[.]” and “[u]sing accelerometer measurements, it should be possible to classify driving habits as safe or unsafe.” *Id.* The technique described in Langle2009 “look[s] at the two horizontal axes to determine the safety level of the driver. *Id.*

93. Langle2009 characterizes unsafe driving activity based on driving behaviors, such as braking and lane changing. USAA-1029, 1. Figure 2 illustrates acceleration measurements indicative of unsafe acceleration.

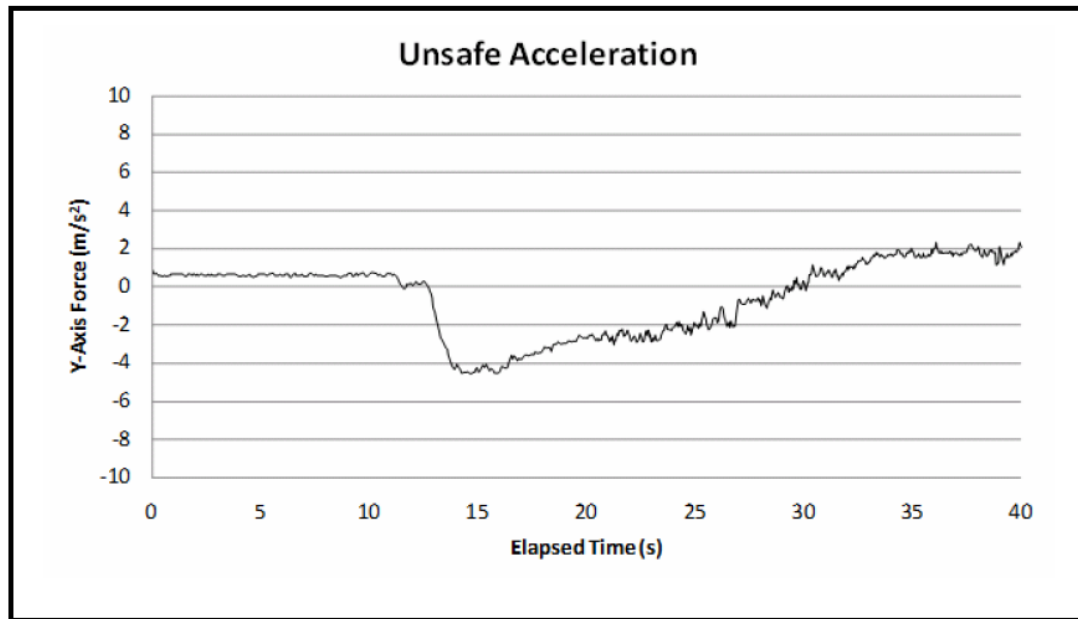


Figure 2. Unsafe Acceleration

USAA-1029, Fig. 2

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

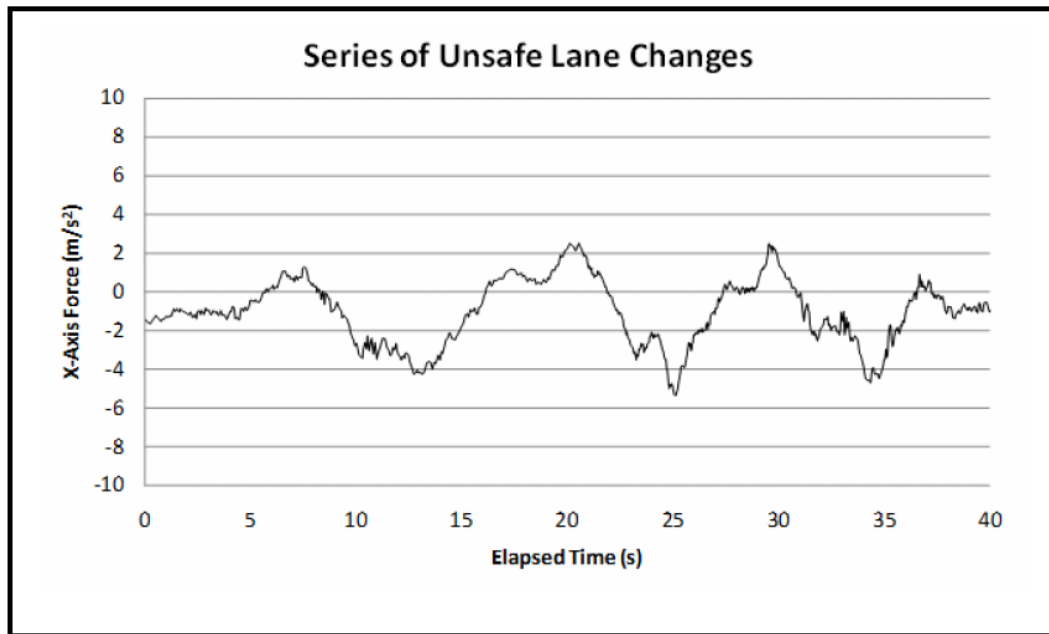


Figure 5. A Series of Unsafe Lane Changes

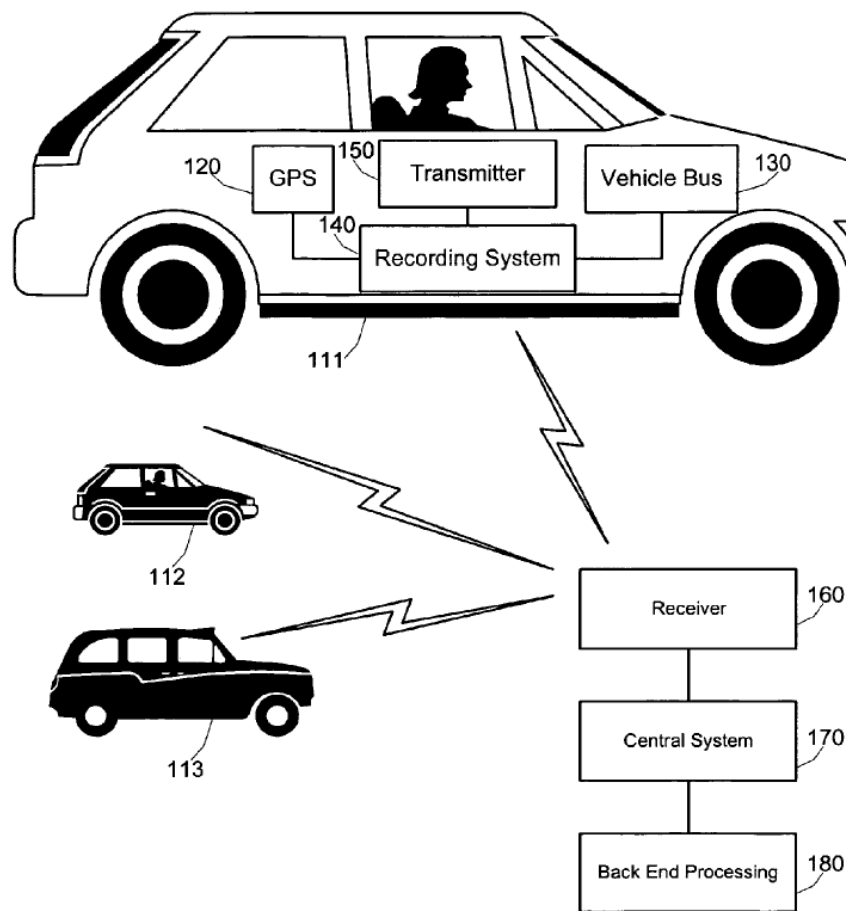
USAA-1029, Fig. 5

3. *Overview of Warren*

95. 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.*

96. 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 and/or transmitted to central system 170. *Id.*



USAA-1030, Fig. 1

97. 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].

98. 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]

XI. [GROUND 1A] CURRY AND RABU MAKES CLAIMS 1-3, 5, 9, AND 11-13 OBVIOUS

99. For the reasons articulated in detail below, and based on my review of the '487 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 Curry and Rabu makes the elements of claims 1-3, 5, 9, and 11-13 obvious.

A. Curry-Rabu Combination

100. A POSITA would have found it obvious to integrate Rabu's dock status sensing and associated mode-shifting capabilities into Curry's phone, thereby enhancing the Curry phone's ability to promote safe driving. As explained below, the result is a device with added functionality (enhanced phone provided by Curry-Rabu, or "Curry-Rabu phone"), 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), and of appropriately restricting phone use and/or adjusting user driving scores depending on a type of driving period determined.

101. For example, the Curry-Rabu phone would leverage orientation and motion data from its accelerometer to determine both vehicle motion and phone docking status upon, for example, a user accepting a phone call while driving, or manually switching from a stationary to driving activity mode through interactions with the phone's user interface. USAA-1013, 3:1-10, 4:21-33, 8:13-10:42, 15:7-22, Figs. 1, 4-5, 7-8. Consistent with both Curry and Rabu, the Curry-Rabu phone would appropriately restrict phone interactions depending on the determined status.

USAA-1005, 16:30-17:7, Figs. 3, 6; USAA-1013, 8:13-10:42, Fig. 5. Curry describes a mobile phone client 110 determines phone 106's operating mode based on sensor data, to derive driving behavior information based on sensor data, and to generate a user safety score that accounts for that information, which may include whether and how the user interacts with the phone while driving, and whether the user engages in other risky driving behaviors such as speeding. USAA-1005, Abstract, 3:1-4:6, 7:5-22, 8:29-12:18, 13:27-14:26, 17:1-18:4, Figs. 1, 3, 6.

102. Curry describes two modes: (1) a "communication" operating mode that allows for normal phone usage and (2) "a GPS monitoring/navigation" operating mode that can restrict calling, texting, and/or software capability on the phone for purposes of promoting driving safety. USAA-1005, 10:15-11:14, 13:20-16:22, Figs. 3, 4. Curry describes that phone 106 switches between these alternative operating modes. USAA-1005, 13:20-14:4, 16:18-22. One way is based on an "activity mode" (e.g., "remaining substantially still" or "driving") that can be activated by the phone's user and/or in response to sensor data. *Id.* Another way is a manual adjustment where user inputs can, for example, "change[] the activity mode...from stop to driving," and "the system uses acceleration data...to determine the change..., and then further estimate the motion type before or after the change." *Id.*, 12:20-26, 15:18-22, Fig. 3. "Access to...calling, texting, and...

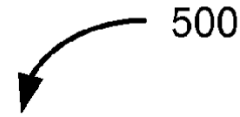
applications” can be restricted, and “driver safety data can be communicated,”
“based on the activity mode....” USAA-1005, 16:30-17:7, Figs. 3, 6.

103. To further promote safe driving, Curry suggests correlating different activity modes (e.g., stop, driving) with different operating modes (e.g., different levels of restrictions on phone use), and accounting for the context of phone usage when generating a driving score for a particular driver. USAA-1005, 2:3-3:28, 15:8-16:33. For example, in one embodiment, Curry contemplates an all-or-nothing approach to restrictions on phone activity when phone 106 is placed in a monitoring operating mode, it elsewhere recognizes that such an approach is not always appropriate, and that it can be better to correlate different driving contexts with different phone restrictions. USAA-1005, 2:3-3:28, 15:8-16:33. For instance, “in contrast to an embodiment that does not allow any non-emergency cell phone communications at driving mode, especially for teen drivers,” Curry contemplates “commercial fleet drivers” being allowed to “communicate with dispatchers or other drivers using a cell phone while driving.” USAA-1005, 15:8-23. As another example, Curry describes allowing “certain types of communication modes (such as talking while driving through headsets)” when “the driving condition or context requires very low attention from a driver.” USAA-1005, 15:14-17.

104. Curry suggests a nuanced approach to phone restrictions and to driver scoring that takes into account the context within which a phone is used. But Curry

is focused more on functionality than implementation details. As such, Curry would have motivated a POSITA to seek related practical solutions. USAA-1005, Abstract, 2:3-3:28, 15:8-16:33.

105. A POSITA would have readily found relevant solutions within Rabu, and would have been motivated to pursue Rabu's solutions within the systems and processes. For example, Rabu explains at length that a smart phone processor leveraging a "generally conventional" accelerometer such as that found in Curry's phone can be used to determine both an orientation angle and motion status of the smart phone, and that approximately accounts for 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. Similar to Curry, and as shown in Rabu's Fig. 5 (reproduced below), Rabu describes switching operating modes based on determining that the phone is "docked in a moving vehicle" (as opposed to being "handheld while located in a moving vehicle"). USAA-1013, 8:13-10:42, Figs. 5, 7, 8.

500


PMD Modes	Description
A	PMD handheld while located in a moving vehicle.
B	PMD resting in a moving vehicle
C	PMD handheld while person is in motion.
D	PMD docked in a moving vehicle
E	PMD docked in a desktop dock and stationary
F	PMD resting on a stationary surface
G	PMD docked in a stationary vehicle

USAA-1013, Fig. 5

106. Rabu’s teachings also enhance Curry’s contemplated use of a phone usage restriction to improve driver safety. USAA-1005, 7:5-22, 9:5-11, 8:30-9:33. Given Curry’s recurrent concern of reducing “risky behaviors” while driving, a POSITA would have looked for solutions that enable users to more safely use their phones while driving. *Id.*, 16:7-22. A POSITA would have found a solution in Rabu, which, as discussed in Section X.A.2 and shown in Figure 5 above, uses a dock to determine “the type of motion” to differentiate between a phone being handheld or docked while in a moving vehicle. USAA-1013, 3:1-10, 4:21-33, 6:39-43, Figs. 1, 4. When docked in a moving vehicle, the dock further enables the phone to “automatically enable[s] the speaker phone feature for all telephone calls made or received.” *Id.*, 6:39-43.

107. Similar to Curry, each of Rabu's defined modes of operation include appropriate levels of restrictions on phone use. USAA-1013, 1:36-2:14, 5:53-7:6, 12:26-38, Fig. 5. For example, if the phone "is being held by the driver," then it can "prevent the driver from sending or receiving text messages while driving." USAA-1013, 12:38-43. Conversely, the phone is held within a dock located within the vehicle, a POSITA would have found it obvious to decide to change the phone's mode of operation to one involving relatively fewer restrictions to phone use. USAA-1013, 3:1-10, 4:21-33, 6:39-43, Figs. 1, 4. In another example, consistent with Curry's description of allowing drivers to "talk[] while driving through headsets," (i.e., hands free) and as taught by Rabu, a POSITA would have found it obvious to leverage motion and orientation data from the same accelerometer already present in Curry's phone to determine that a driver may leverage a speaker mode of a docked phone to talk while driving. USAA-1005, 15:14-17; USAA-1013, 6:39-43 ("if mode D is selected, the PMD can automatically enable the speaker phone feature for all telephone calls made or received using the PMD").

108. Indeed, the combined disclosures of Curry and Rabu would have motivated a POSITA to supplement Curry's teachings of determining the start of a driving period based on user inputs (e.g., initiating a motion estimation process based on a user's interaction with the phone's user interface when accepting a

phone call, or when manually changing between activity modes) and sensor data (e.g., accelerometer motion and orientation data used to differentiate between defined driving periods in which Curry's phone 106 is hand-held, and those in which phone 106 is instead docked within the vehicle. USAA-1005, 15:14-17; USAA-1013, 5:61-6:21, 6:39-43, 8:1-4; Figs. 3, 4, 5-8.

109. The POSITA would have found obvious that enhancing Curry's system to define additional driving modes (including one in which the phone is docked, and another in which the phone is undocked), and to appropriately restrict phone use and/or adjust user driving scores depending on a type of driving period determined from user inputs and sensor data, would introduce multiple additional advantages.

110. The Curry-Rabu combination would have increased user tolerance for Curry's monitoring techniques. USAA-1005, 7:5-22, 8:5-18, 11:3-14; USAA-1013, 1:36-2:14. For example, Rabu's docking status enabled a determination of when a phone is docked within a moving vehicle, which can then be inferred to mean that a user is not presently using the phone for texting when the vehicle is being driven. Rabu's docking status would have also improved Curry's use of an estimated context of mobile phone use in identifying unsafe driving behaviors. For example, knowing the docking status would have enabled differentiation between (i) a user holding and using the phone while driving and (ii) using the phone while

docked and while driving. The second scenario in this example is less likely to distract the user and less likely to be determined to represent an unsafe driving behavior.

111. The Curry-Rabu combination would have also increased user participation in Curry's monitoring techniques based on increased user tolerance. USAA-1005, 7:5-22, 8:5-18, 11:3-14; USAA-1013, 1:36-2:14. The combination would have improved safety for the user, passengers, and those outside the vehicle since the user is more likely to participate in Curry's monitoring. For example, given that a phone can be docked while a vehicle is driven using Rabu's dock, a user is less likely to be distracted while driving the vehicle when using the phone for calls.

112. Another advantage provided by the Curry-Rabu combination is 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-1005, 3:24-4:6, 7:5-22, 8:23-28; 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 other movements unrelated to vehicle motion.

113. Yet another advantage is the generation of more nuanced safety scores that take into account whether the user has violated permissions by using the phone in a hand-held mode, or instead used the phone during a given driving period only while docked. USAA-1005, 7:5-22, 9:31-33, 10:3-12, 11:3-14, 13:3-19; USAA-1013, 2:61-3:10, 3:46-4:3, 5:61-6:21. For example, the Curry-Rabu combination would have enabled calculation of a safety score to represent a lower risk of unsafe driving behavior if a user drives a vehicle while using the phone in docked mode (compared to the user driving the vehicle using the phone in hand-held mode). This new capability would have also enabled new types of restrictions/policies that are already contemplated in Curry's disclosure. The Curry-Rabu combination would have also enhanced utility for third parties to leverage those more nuanced driving scores in, for example, determining insurance premiums that reflect the realities of different levels of crash risk. USAA-1005, 4:7-11, 7:5-22, 10:3-12, 11:26-12:2; USAA-1013, 2:61-3:10, 3:46-4:3, 5:61-6:21.

114. The advantages of the Curry-Rabu combination discussed above would have motivated a POSITA to integrate Rabu's teachings into Curry's systems. This would have enabled a phone both to determine a start of a driving period based on user inputs and sensor data. The combination would have also enabled the phone to be removably attached to the vehicle via a dock while the vehicle is in use. Additionally, the docking status would have enabled the phone to

adjust the phone's operating modes, make determinations of user driving behaviors, and generate safety scores. USAA-1005, 10:15-11:14, 13:20-16:22, 17:30-18:7, Figs. 3, 4, 6; USAA-1013, 24:8-3:10.

115. Moreover, configuring Curry'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 Critical Date. For example, Rabu and Curry both use the same type of hand-held phone and contain the same types of internal sensors (GPS, accelerometers). Indeed, the change would have amounted to nothing more than the use of a known technique to improve similar devices—in each instance a smart phone equipped with a generic accelerometer—in a similar way, and combining prior art elements according to known methods to yield the predictable results described above.

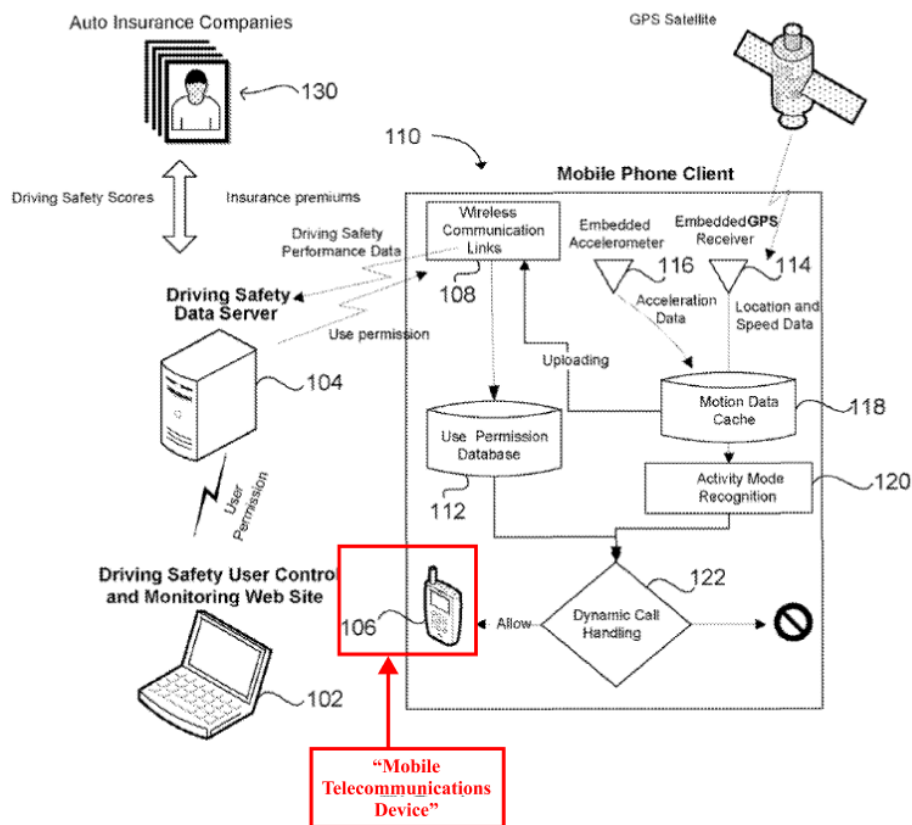
116. The elements of the Curry-Rabu combination would each perform functions they had been known to perform prior to the combination—the phone would perform the same functions to adjust operating mode based on user inputs and sensor data, to derive driving information, and to generate user scores but, as taught by Rabu, would leverage both orientation and motion data from its accelerometer when performing those functions. A POSITA would have naturally expected success when incorporating Rabu's teachings into Curry's systems, as described above.

B. Analysis of Claims 1, 2, 5, 9, and 11-13

1. Claim 1

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

117. To the extent that the preamble is limiting, the Curry-Rabu combination (see Section XI.A) makes it obvious. As shown below, the Curry-Rabu system includes a mobile phone (“*mobile telecommunications device*”), which may be “any type of electronic mobile computing device that may be used while traveling in a vehicle”; for example, an “iPhone 3G smart phone[.]” USAA-1005, Abstract, 2:22-27, 7:5-29, 8:21-27, Fig. 1.



USAA-1005, Fig. 1 (annotated)

118. From this and related descriptions, a POSITA would have found obvious that the Curry-Rabu phone is a mobile telecommunications device. USAA-1005, Abstract, 2:1-27, 3:1-4:28, 10:15-12:18, Fig. 1; *see also* USAA-1013, 3:11-28, 4:15-20, Figs. 1, 4. For example, the “iPhone 3G” smart phone described by Curry was a 3G wireless mobile telecommunications device additionally featuring Bluetooth and WiFi connectivity; the iPhone 3G included GPS and accelerometer sensors, a processor, and flash memory for internal storage. USAA-1005, 2:22-27; USAA-1081, 1-5 (describing Bluetooth pairing of the iPhone 3G to a vehicle’s computer system); USAA-1079, 2-8; *see also* USAA-1016, ¶¶[0046]-[0063], FIG. 3. As shown below, the iPhone 3G further included a user interface in the form of a touchscreen and various buttons enabling a user to interact with downloaded applications. USAA-1005, 1:22-27; USAA-1078, 21-47; USAA-1079, 2-3; USAA-1080, 16-35, 87-92. The included “Maps” application, for example, provided users with “detailed driving directions.” USAA-1080, 20, 87-92.

iPhone at a Glance



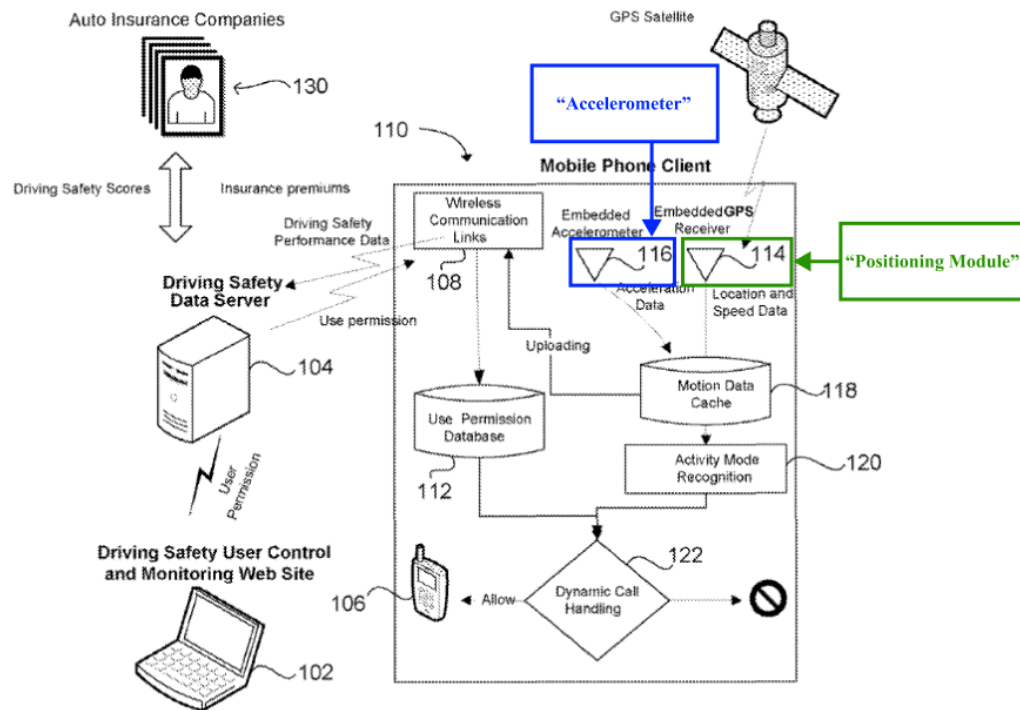
USAA-1080, 38 (left), 90 (right)

119. Curry further describes a client application 110 that can be downloaded “from the server 104 to the mobile phone 106,” which would have enabled the Curry-Rabu phone to determine, based on user inputs and “location, speed, and acceleration data from” embedded “GPS sensor 114 and accelerometer 116,” whether a vehicle within which the phone is located is being driven. USAA-1005, 8:20-9:33. Client 110 additionally enables a phone to process “raw data” from a driving period to derive driving information associated with a user’s driving behavior (“*log driving activity associated with a vehicle*”), and to use the derived information to generate a “driving safety score” for the user. USAA-1005, Abstract, 7:5-8:2, 8:29-10:26, 13:27-33. From this and related description, a POSITA would have found it obvious that the phone is configured to log driving

information associated with a vehicle. USAA-1005, Abstract, 2:1-27, 3:1-4:6, 4:7-11, 7:5-22, 9:31-33, Fig. 1.

[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;

120. The Curry-Rabu phone features embedded sensors (“*a sensor set*”), including accelerometer 116 (“*accelerometer*”) and GPS receiver 114 (“*positioning module*”). USAA-1005, 2:23-27 (“For example, both GPS and accelerometer sensors have been equipped in iPhone 3G smart phones from Apple Inc.”), 3:2-15 (“[a]n embedded accelerometer and a GPS receiver are included in the wireless device”), 7:24-8:2 (“The term GPS is used throughout the specification to refer to positional tracking technology”), 8:30-9:3, 10:16-26, 11:15-25, Fig. 1; USAA-1079, 2-3; USAA-1080, 87, 88, 108; *see also* USAA-1013, 3:11-28, 4:15-58, Figs. 1, 4.



USAA-1005, Fig. 1 (annotated)

Data from the embedded sensors of Curry-Rabu phone and driving information derived from that data is used, for example, to “monitor driving safety performance,” to “prevent unsafe driving behaviors,” and to “generate driving score[s].” USAA-1005, 7:5-8:2.

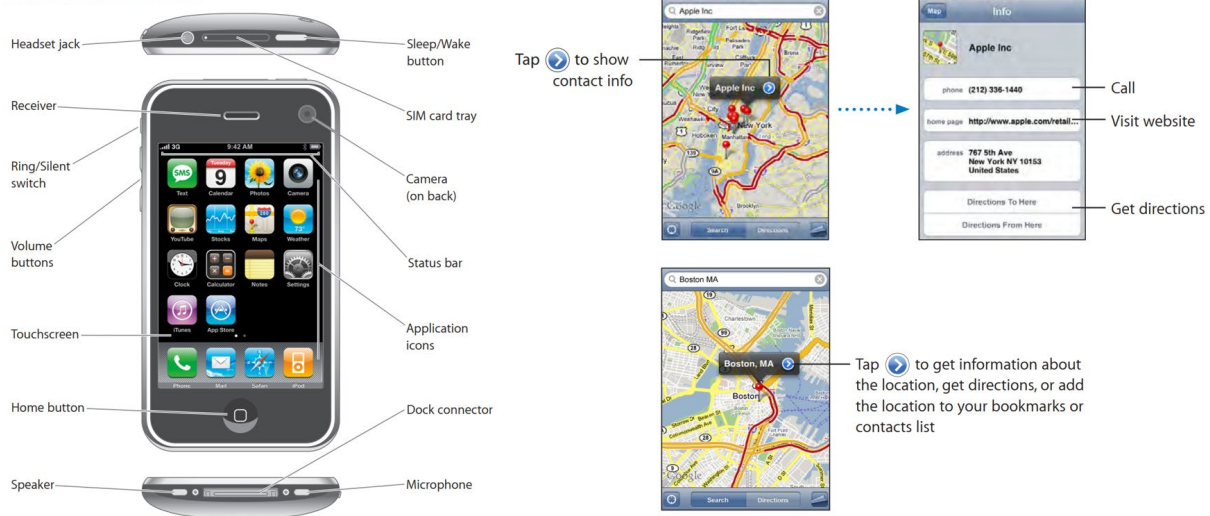
[1.3] a user interface;

121. A POSITA would have understood and found obvious that the Curry-Rabu phone includes a user interface. USAA-1005, 8:5-18. For example, Curry notes that a “graphical *user interface*” can be installed on a “smart phone,” indicates that the “graphical user interface” can be “configured to display the driver motion data cache, the user permission data, and the driver safety statistic

to...selected individuals,” and additionally describes various examples of user interactions with a phone that a POSITA would have understood to be enabled through a user interface. USAA-1005, 8:5-27 (“A user can download the required software from the server 104 to the mobile phone 106 to set up the client unit on the phone”), 21:23-25, 9:5-11 (“the mobile phone...may be used while driving, walking or remaining still”), 9:13-20 (“[t]he phone can...signal to the driver...so that the driver can decide whether to...take [a] call or call back later”), 10:15-26 (“[i]f the status of the mobile phone user is recognized as driving, the mobile phone can automatically switch to the GPS navigation mode”).

122. Moreover, a POSITA would have understood and found obvious from Curry’s disclosure of “GPS monitoring/navigation mode” that the Curry-Rabu phone includes a user interface. USAA-1005, 10:15-26. Indeed, smart phones featuring monitoring and navigation applications with graphical user interfaces were well-known by the Critical Date. *See, e.g.*, USAA-1008, Fig. 2; USAA-1011, Figs. 4, 5; USAA-1016, ¶¶[0072]-[0073], Figs. 1-5, 7-9; USAA-1013, 3:11-28, 4:15-20, 4:59-5:2, Fig. 4; USAA-1078, 25. For example, and as shown below, the “iPhone 3G” smart phone described by Curry included a user interface in the form of a touchscreen enabling a user to interact with a “Maps” application. USAA-1005, 2:22-27; USAA-1078, 21-47, 68, 90; USAA-1079, 2-3; USAA-1080, 16-35, 87-92 (detailing and illustrating various user interactions).

iPhone at a Glance



USAA-1080, 16 (left), 92 (upper right), 87 (lower right)

123. Similarly, a POSITA would have understood and found obvious that the Curry-Rabu phone would feature a touchscreen and various graphical user interfaces enabling the user to interact with downloaded applications (e.g., client application 110 and/or related applications such as the “driving safety monitoring program” described by Curry in connection with Curry’s Fig. 3). USAA-1005, 8:5-18, 9:20-27, 13:20-26 (“the motion recording process can be activated...by the user of the phone”), 16:18-22; 21:23-25; USAA-1015, 4 (“At the most basic level, a computer is a device consisting of...[a] processor...[a] memory...[and a] mechanism for transferring data to and from the outside world”).

[1.4] a processor; and

124. Curry discloses that its described processes may be “implemented in software for execution by various types of processors.” USAA-1005, 5:3-10.

Consistent with that disclosure, Curry explains that “[a] user can download...required software...to the mobile phone 106 to set up the client unit [110] on the phone,” and that “the mobile phone client 110 can record location, speed and acceleration data from sensors embedded in the wireless device...to a local motion data cache 118 for further processing.” USAA-1005, 3:24-26, 8:20-27. A POSITA would have understood that the storage of data in a “local” cache within the Curry-Rabu phone “for further processing” implies the existence of a processor within the same phone. USAA-1005, 8:20-27, Fig. 1; USAA-1015, 237-250 (“[a] cache memory is a small, temporary, but fast memory that the processor uses for information it is likely to need again in the very near future”).

125. A POSITA would have also understood and found obvious that the Curry-Rabu phone includes a processor, at least because Curry explains that “the term ‘mobile phone’ can include any type of electronic mobile computing device,” and because a POSITA would have understood that “[a]t the most basic level, a computer is a device consisting of...[a] processor to interpret and execute programs...[a] memory...[and a] mechanism for transferring data....” USAA-1005, 6:3-10; USAA-1015, 4. The “iPhone 3G” described by Curry as an exemplary mobile phone including GPS and accelerometer sensors, further included a processor. USAA-1005, 2:22-27; USAA-1079, 2-8; USAA-1013, 3:11-28, 4:15-20, 5:3-14, Figs. 1, 4; USAA-1016, ¶¶[0046]-[0063], FIG. 3.

[1.5] a memory;

126. Curry describes “memory devices” that store data, such as “executable code,” “instructions” or “code segments among different programs.” USAA-1005, 6:11-20. A POSITA would have understood that the phone would have included memory devices for storing data.

127. The “iPhone 3G” described by Curry as an exemplary mobile phone also included a memory. USAA-1005, 2:22-27; USAA-1079, 2-8; *see also* USAA-1013, 3:11-28, 4:15-20, 5:3-14, Figs. 1, 4; USAA-1016, ¶¶[0046]-[0063], FIG. 3. The “iPhone 3G” also included flash memory for internal storage. USAA-1005, 2:22-27; USAA-1079, 2-8; *see also* USAA-1013, 3:11-28, 4:15-20, 5:15-33, Figs. 1, 4; USAA-1016, ¶¶[0046]-[0063], FIG. 3.

128. Moreover, Curry expressly describes that “[a] user can download...required software...to the mobile phone 106 to set up the client unit [110] on the phone,” and that “the mobile phone client 110 can record location, speed and acceleration data from sensors embedded in the wireless device...to a local motion data cache 118 for further processing.” USAA-1005, 3:24-26, 8:20-27, Fig. 1. A POSITA would have understood both that the downloading of a program to a phone implies the existence of internal memory within the Curry-Rabu phone to which the program is downloaded (e.g., flash memory), and that the

term “cache” refers to local cache memory. *Id.*; USAA-1015, 233-250, 606, 614, 622.

129. Curry additionally describes “further processing” of data stored in cache 118 by a “user activity mode recognition program 120,” the transmission of “activity mode estimation results” from a mobile phone to a driver safety data server, and the display through “an interactive website” of derived driving behavior information including “possible violations of mobile phone use or unsafe driving behavior.” USAA-1005, 8:29-9:28. From this and their related knowledge of the architecture of phones (e.g., iPhone 3G), a POSITA would have understood and found obvious that driving behavior information derived from sensor data is stored locally in a memory on the Curry-Rabu phone prior to its later transmission and display. USAA-1005, 7:5-22 (“the driving safety data can be recorded in mobile phones and then transmitted”), 8:29-9:28, 13:20-16:6, Fig. 3 (depicting a “local driving safety performance database 324” in which data from an “activity mode recognition module” is stored).

***[1.6] the mobile telecommunications device configured to:
determine, based on 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;***

130. 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.

131. The ’487 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 ’487 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, 3:31-61.

132. 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.

133. As explained in Section XI.A, a POSITA would have configured the Curry-Rabu phone to determine, based on user inputs, orientation, and motion sensor data from accelerometer 116, a start of a driving period during which phone 106 is removably attached to the vehicle via a docking station and the vehicle is in

use. USAA-1005, Abstract, 1:3-2:28, 9:15-10:14, 12:20-15:33, 16:30-17:7, Figs. 1, 3, 4, 6; USAA-1013, 3:1-10, 4:21-33, 8:13-10:42, Figs. 1, 4-5, 7-8. The Curry-Rabu combination meets each of the requirements of limitation [1.6] through obviousness in multiple ways. The limitation is first met by a configuration of the Curry-Rabu phone in which the phone uses orientation and motion data from its accelerometer to determine both vehicle motion and phone docking status upon a user accepting a phone call while driving (i.e., concurrent use of orientation data and user input data). The Curry-Rabu combination also meets this limitation through other configurations where use input data and orientation data is not concurrently used since the limitation does not include claim language describing concurrent use of user input data or sensor data in determining a start of a driving period.

134. Curry describes multiple embodiments in which a phone determines a start of a driving period during which the phone is located within a moving vehicle, based on user inputs received through a phone's user interface (e.g., a user accepting a phone call, or manually switching between activity modes using the phone's touch screen and GUI) and motion sensor data generated by a phone's embedded accelerometer; in each instance, Rabu would have motivated a POSITA to enhance Curry's phone by configuring it to leverage orientation data from the

same accelerometer to determine whether the phone is removably attached to the vehicle. USAA-1013, 3:1-10, 4:21-33, 8:13-10:42, 15:7-22, Figs. 1, 4-5, 7-8.

135. As shown in Figure 1 (below), client 110 enables the phone to determine, based on user inputs (e.g., accepting a phone call, manually changing activity modes) and sensor data (e.g., “location, speed, and acceleration data from” an embedded “GPS sensor 114 and accelerometer 116”) whether an associated vehicle is being driven. USAA-1005, 6:5-22, 8:5-11, 7:30-8:33, 15:7-22. Client 110 also processes “raw data” from a driving period to derive information associated with a user’s driving behavior, including whether the phone is being used during the driving period in a manner violating permissions, and whether the user engages in other unsafe driving behaviors such as speeding. USAA-1005, 7:5-22, 8:30-9:33.

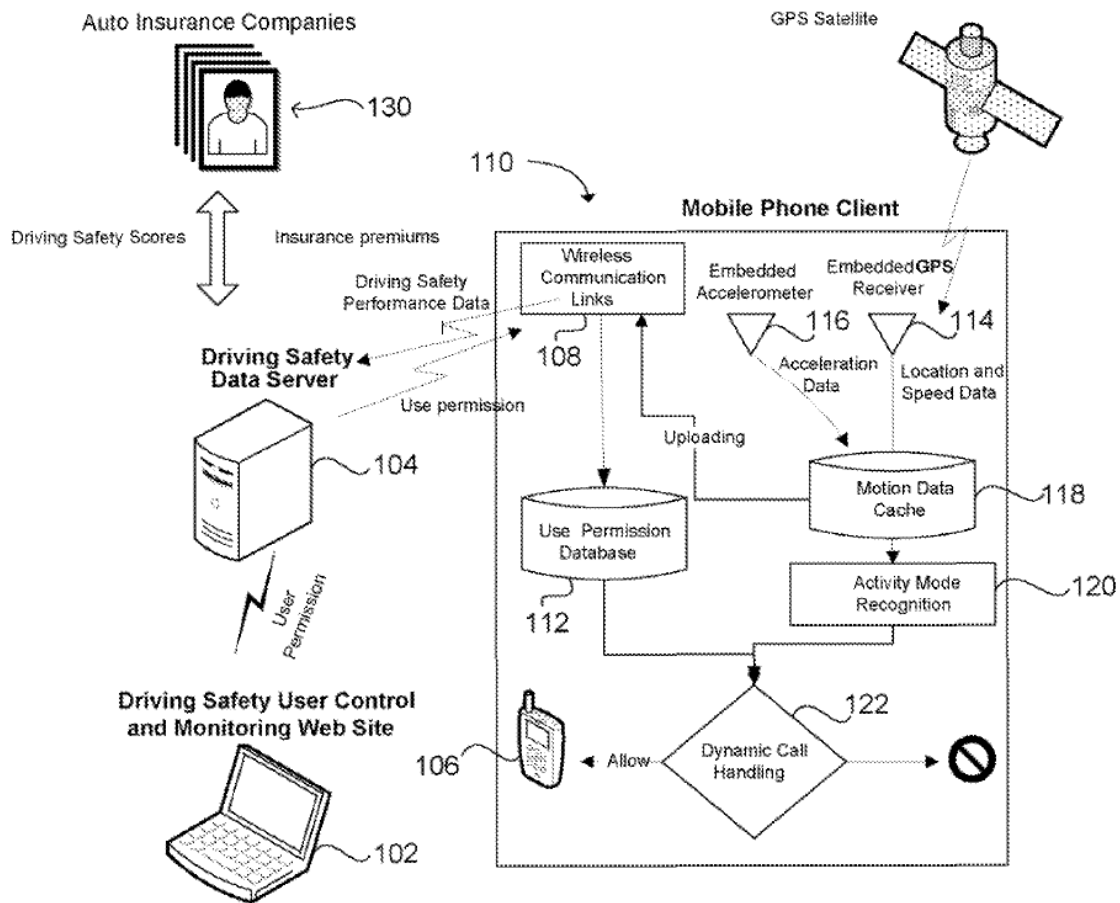
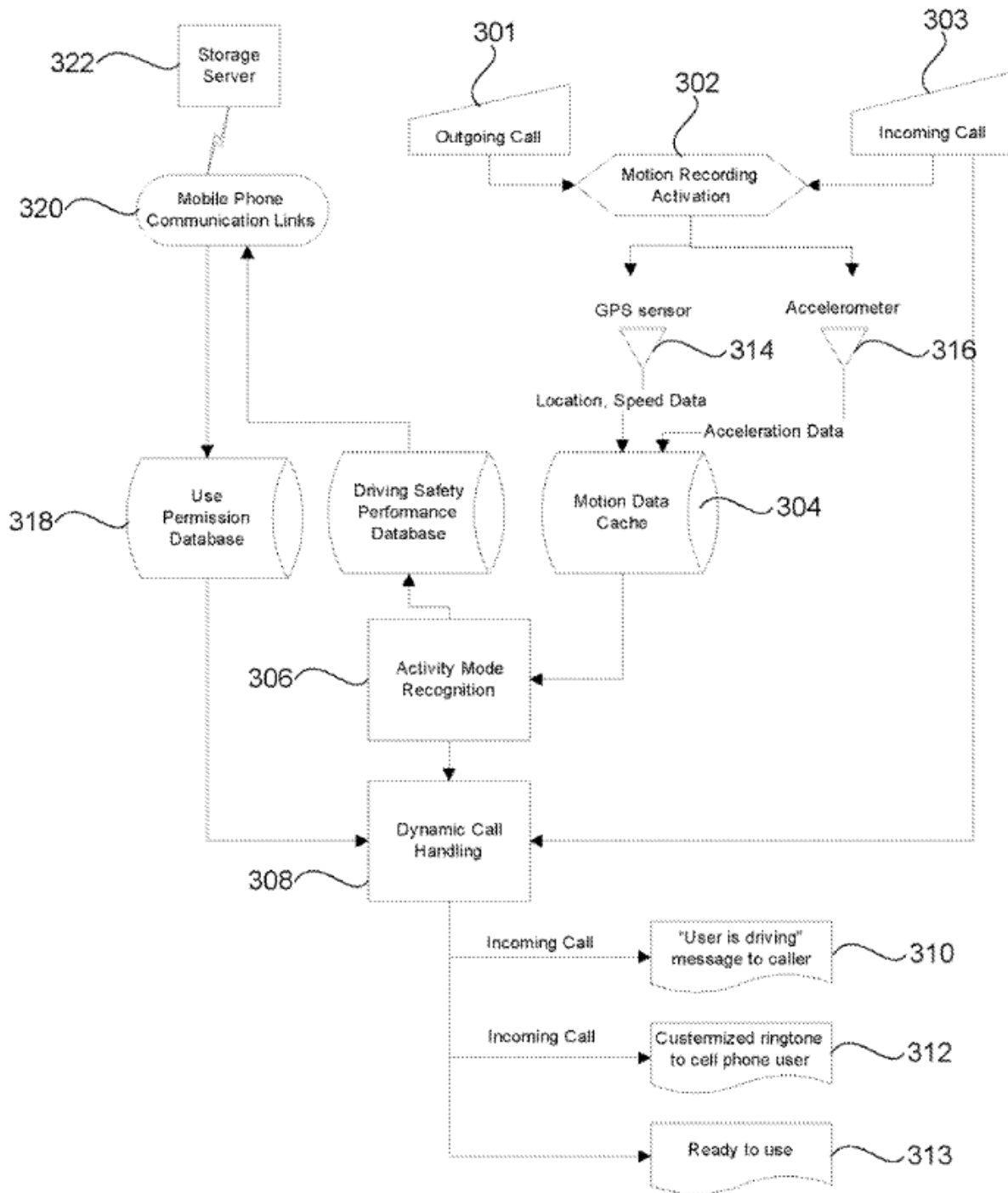


FIG. 1

USAA-1005, Fig. 1

136. As another example, with Curry's Fig. 3 (below), a "driving safety monitoring program on a mobile phone client" determines, based on user inputs (e.g., user interaction with the phone based on receiving an incoming phone call) and "recorded time stamped [sensor] data," whether the phone is located within a vehicle that is in use, and that is further configured both to derive related driving information, and "to allow or disallow users to receive or make a call, text a

message...or use other components or software programs,” based on that determination. USAA-1005, 13:20-14:26.



USAA-1005, Fig. 3

137. As another example, in connection with Curry's Fig. 4 (reproduced below), Curry describes determining the start of a driving period based on a combination of user inputs received in relation to a call or text and motion data from the phone's sensor set. USAA-1005, 16:7-22. "Right after an incoming phone [call] or text message is received or an outgoing phone call is made" (i.e., right after receipt of user inputs), "the GPS sensor and accelerometer...start to record a motion time series... to determine the type of the current activity," so as to allow identification of "risky behaviors of talking while driving or texting while driving" that can be used to adjust a driving score associated with the driver. USAA-1005, 16:7-22.

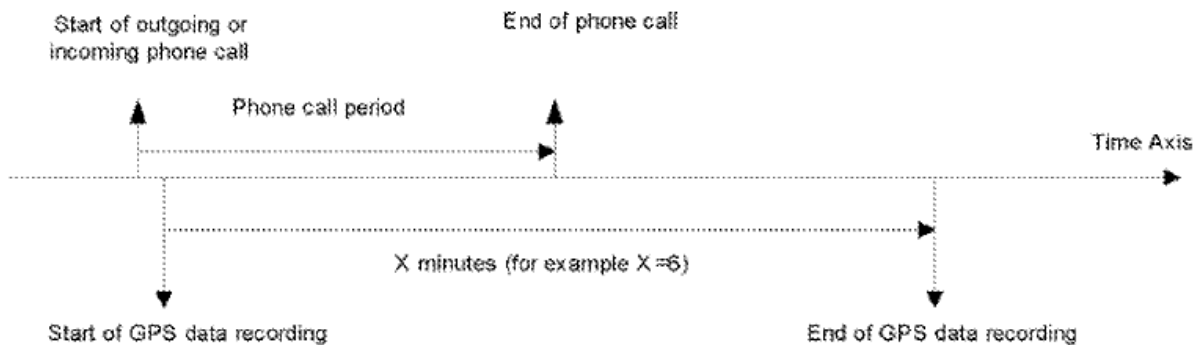


FIG. 4

USAA-1005, Fig. 4

138. As explained in Section XI.A, the POSITA would have found obvious that extending these and other teachings of Curry to further leverage orientation data from the phone's embedded accelerometer to determine a start of a driving

period during which the phone is removably attached to the moving vehicle via a docking station, would enable the phone to differentiate instances in which the phone is hand-held during a driving period from those in which the phone is instead removably attached to the vehicle during the driving period. USAA-1005, 15:14-17; USAA-1013, 1:36-52, 6:49-7:6. As noted, that capacity for enhanced differentiation would in turn have enabled the enhanced Curry-Rabu phone to make corresponding adjustments to phone access restrictions associated with the phone's operating modes, to determinations of user driving behaviors, and to generation of user driving scores, with multiple additional advantages flowing therefrom. USAA-1005, 9:15-10:14, 12:20-15:22, 16:30-17:7, Figs. 3, 4, 6; USAA-1013, 5:61-6:21, 6:39-43, 8:1-4; Figs. 3,4, 5-8.

139. A POSITA would have configured the Curry-Rabu phone to determine a start of a driving period during which the phone is docked (*“removably attached to the vehicle”*) while the vehicle is being driven (*“vehicle is in use”*). USAA-1005, Abstract, 2:3-3:28, 10:15-11:14, 13:20-16:33, 17:30-18:7, Figs. 1, 3, 4, 6; USAA-1013, 3:1-10, 4:21-33, 8:13-10:42, Figs. 1, 4-5, 7-8. Further, and as explained above, Curry-Rabu makes that determination based on concurrent use of a user's interaction with the Curry-Rabu phone (*“the inputs received by the user interface”*) and both motion and orientation data from the embedded accelerometer (*“sensor data from the device's sensor set”*).

[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;

140. The Curry-Rabu phone processes sensor data (e.g., motion and orientation data) recorded by its embedded sensors (e.g., accelerometer 116) (“***sensor data***”) during a driving period to identify “driving behavior” information, e.g., “talking...or texting...while driving” and behavior such as “speeding, abnormal acceleration, abnormal deceleration, and taking sharp turns” (“***driving information associated with how the vehicle is driven***”). USAA-1005, 7:13-29, 8:21-27, 8:30-9:33, 10:15-26, 11:3-17.

141. This processing is performed by client 110. Specifically, client 110, which can be downloaded “from the server 104,” enables a phone to determine, based on “location, speed, and acceleration data from” embedded “GPS sensor 114 and accelerometer 116” whether the vehicle is being driven, and to process the “raw [sensor] data” during a driving period to derive and store information associated with a user’s “driving behavior,” including “behavior such as talking...or texting...while driving” and behavior such as “speeding, abnormal acceleration, abnormal deceleration, and taking sharp turns.” USAA-1005, 7:13-29, 8:21-27, 8:30-9:33, 10:15-26, 11:3-17. As shown in Curry’s Fig. 1 (reproduced below), client application 110 further enables a phone to process the derived driving information to generate “driving safety performance data” for the user,

including a “driving safety score” that can be wirelessly communicated to third parties such as auto insurance companies. USAA-1005, Abstract, 3:1-4:6, 7:13-17, 8:29-10:12, 11:3-17, 13:27-33.

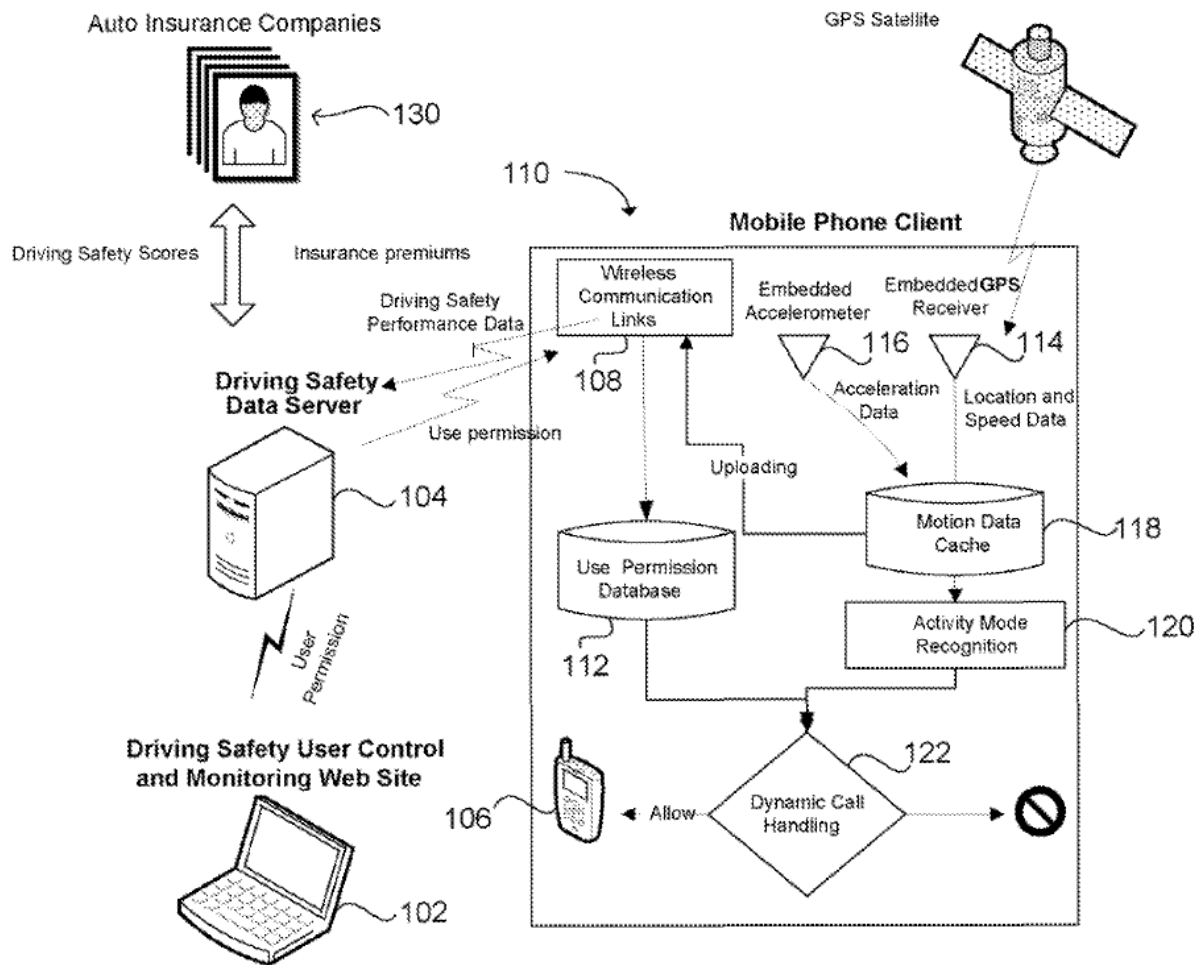


FIG. 1

USAA-1005, Fig. 1

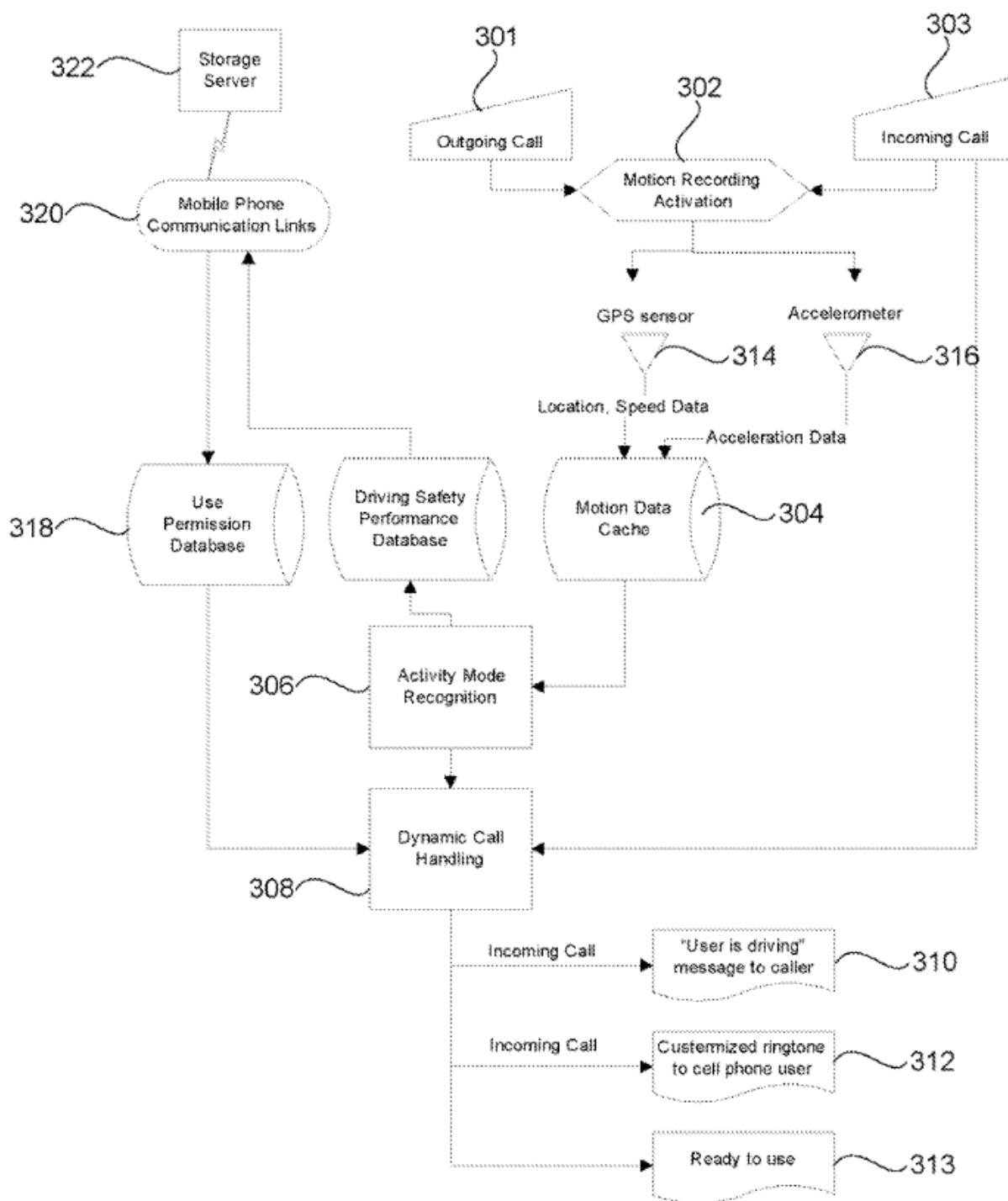
142. A POSITA would find it obvious from Curry to process such driving information when deriving unsafe driver behaviors, such as “possible violations of mobile phone use or unsafe driving behavior[.]” USAA-1005, 7:5-22, 8:29-10:12,

13:20-16:6, Figs. 1, 3; USAA-1015, 233-250. Curry explains, for example, that “[w]hen a call is made or received using...mobile phone 106, the mobile phone client 110 can record location, speed and acceleration data from [embedded] sensors...to a local motion data cache 118 for further processing.” USAA-1005, 8:29-8:1. “The local data cache can be used to store raw data for an extended...period of time in order to provide sufficient information for a user activity mode recognition program 120,” which “estimates the context of mobile phone use”; “[f]or example...driving, walking or remaining still.” USAA-1005, 9:1-11. “Through mobile phone communication links, motion data and activity mode estimation results of a user of the mobile phone 106 can be transmitted to the driving safety data server 104, and further displayed through an interactive user control website to enable visualization of possible violations of mobile phone use or unsafe driving behavior such as speeding, abnormal deceleration and sharp turns.” USAA-1005, 9:22-28.

143. In connection with Curry’s Fig. 3 (reproduced below), which “illustrates a driving safety monitoring program on a mobile phone client,” Curry describes another example in which “[e]ach motion measurement from [a] GPS sensor and accelerometer” is associated “with a timestamp” and stored “in a local motion data cache 304 for each pre-specified sampling interval.” USAA-1005, 13:27-31. An “activity mode recognition module 306” uses the “recorded time

stamped data to estimate the type of activity” (e.g., “driving, walking, running or remaining substantially still”) “*in real-time*,” both “to allow or disallow users to receive or make a call, text a message...or use other components or software programs,” and to derive driving information that is stored in local memory.

USAA-1005, 13:20-14:26.



USAA-1005, Fig. 3

144. From this and related description, a POSITA would have found obvious that client application 110 causes Curry's phone to process sensor data from phone's sensor set during the determined driving period to derive "possible violations of mobile phone use or unsafe driving behavior" (*driving information associated with how the vehicle is driven*). USAA-1005, 7:5-22, 8:29-10:12, 13:20-16:6, Figs. 1, 3; USAA-1015, 233-250. Curry also describes various means of processing sensor data, reinforcing the obviousness of sensor data being processed to derive the above and other driving information.

145. For example, data from cache 304 and module 306 that signals whether the mobile phone is "available for use" and/or "traveling at a high rate of speed" can be stored in the mobile phone's "local driving safety performance database 324," and can be transmitted to an "outside storage server 322" through "mobile phone communication links 320." USAA-1005, 11:3-14, 13:31-14:26. The additional example from Curry in connection with Curry's Fig. 3 would have further confirmed to a POSITA that a mobile phone client causes Curry's mobile phone to process sensor data from a sensor set during the determined driving period to derive driving information associated with how the vehicle is driven, and stores a selection of that driving information to local memory (e.g., "local driving safety performance database 324") prior to its transmission to an outside storage server. USAA-1005, 13:20-16:6, Fig. 3.

[1.8] store a selection of the driving information to the memory;¹

146. The Curry-Rabu phone stores information derived from processed sensor data (“*selection of driving information*”) to memory (e.g., motion data cache 118, local memory) (“*memory*”) prior to transmission to the driving safety data server 104. USAA-1005, 7:5-22, 8:29-10:12, 13:20-16:6, Fig. 1; USAA-1015, 233-250. Based on Curry, a POSITA would find it obvious to store all or a subset of the derived driving information in the memory of the Curry-Rabu phone, and, to store a selection of the driving information to the memory. A POSITA would find it obvious to store in the Curry-Rabu phone a subset of (i.e., selection of) the driving information derived from sensor data since Curry explains that certain information (e.g., possible violations of use, unsafe driving behavior) are useful to transmit to safety data server 104. USAA-1005, 7:5-22 (“the driving safety data can be recorded in mobile phones and then transmitted”), 8:29-10:12, 13:20-16:6, Fig. 1; USAA-1015, 233-250. Additionally, a POSITA would have understood that “selection” of recorded data for storage without further detail on the nature of selection may be satisfied by a selection of all recorded data for storage. Curry

¹ 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.”

satisfies this interpretation through storage of recorded data to memory, as discussed above.

147. If the limitation is interpreted to require a selection of a subset for storage, the Curry-Rabu combination renders this interpretation obvious. A POSITA would have found it obvious that the information stored by the Curry-Rau phone is a subset (i.e., selection of) the recorded sensor data since Curry explains that “motion data cache can be compared with the user permission data to enable a driver safety statistic to be calculated.” USAA-1005, 3:24-4:6. This indicates that specific aspects of recorded sensor data are more useful for transmission to safety data server 104 (e.g., motion data indicating possible violations of use, unsafe driving behavior), and thus, selected for storage. A POSITA would have also recognized a variety of entities to which recorded data is relevant (e.g., “user’s parents,” “guardian, “insurance company”) and found obvious to implement Curry-Rabu to store specific aspects of recorded sensor data unique to a particular entity. USAA-1005, 4:8-11. Curry also describes storing data from cache 304 and module 306 signaling whether the mobile phone described in connection with Fig. 3 is “available for use” and/or “traveling at a high rate of speed” during a driving period in the phone’s “local driving safety performance database 324,” before transmitting the data to an “outside storage server 322.” USAA-1005, 11:3-14, 13:31-14:26, Fig. 3.

148. A POSITA would have understood and found obvious that, in each of these examples, data stored in local memory (e.g., in database 324) includes “a selection of the driving information,” at least insofar as Curry describes driving information as being derived from timestamped motion data associated with pre-specified sampling intervals, and further describes the potential to mark activity estimation results for a given interval for further processing at later times. USAA-1005, 13:29-14:4. From this and related description, a POSITA would have understood that each stored activity estimation result includes a selection of driving information for the corresponding interval. USAA-1005, 13:29-14:4; *see also* USAA-1005, Abstract, 2:1-27, 3:24-4:6, 4:7-11, 7:5-22, 8:29-10:12, 13:20-16:6, Figs. 1, 3.

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

149. As discussed for [1.7], the Curry-Rabu phone processes sensor data during a motion recording period to derive driving information, including “possible violations of mobile phone use or unsafe driving behavior.” USAA-1005, 7:5-22, 8:29-10:12, 13:20-16:6, Fig. 1.

150. As another example, Curry describes “a driving safety monitoring program on a mobile phone client” including an “activity mode recognition module 306” that processes “recorded time stamped” data from the mobile phone’s sensor

set during a determined driving period to derive driving information. USAA-1005, 13:20-14:26.

151. A POSITA would have found it obvious to configure a Curry-Rabu phone to derive driving information based on its recorded sensor data alone when considering disclosures by Curry describing examples where data obtained by embedded sensors (e.g., accelerometer 116, GPS receiver 114) being used to derive the driving information. USAA-1005, Abstract, 2:1-27, 3:24-4:11, 7:5-22, 8:29-10:12, 13:20-16:6, Figs. 1, 3.

152. A POSITA would have understood from Curry that vehicle sensor data is not necessary to derive driving information as Curry instead discloses leveraging sensors, processors, and memory found in the Curry-Rabu phone to derive the driving information. USAA-1005, 11:15-25; USAA-1013, 1:36-2:14. For example, in teaching techniques to derive driver safety information, the corresponding disclosures focus on leveraging motion data obtained from sensors embedded in the mobile phone (e.g., accelerometer 116, GPS receiver 114) to derive the driver safety information. USAA-1005, Abstract, 2:1-27, 3:24-4:11, 7:5-22, 8:29-10:12, 13:20-16:6, Figs. 1, 3. In those disclosures, Curry never once describes or suggests leveraging the vehicle's sensors. *Id.* Further, from the combined disclosures of Curry and Rabu, a POSITA would have understood there to be no need to use data from vehicle sensors to derive Curry's driving

information because its phone includes all of the necessary sensors, processing, and memory to derive the driving information, so a POSITA would have found it obvious to derive that driving information without data from the vehicle's sensors, without the complexities and costs that might potentially be involved in obtaining and integrating data from a vehicle's sensor set. USAA-1005, 11:15-25; USAA-1013, 1:36-2:14.

153. This remains true even if a POSITA were to consider Curry's disclosure to be open-ended given other disclosures relating to other types of data distinct from the recorded sensor data. *Compare* USAA-1005, 15:24-32 *with* USAA-1005, 8:29-10:12, 13:20-14:26, Figs. 1, 3. For example, Curry does, in one instance, state that "activity mode recognition module 306" *might use* "local traffic data" obtained from vehicle-to-vehicle communications to "estimate and classify the complexity of driving situations," but a POSITA would have understood and found obvious that "local traffic data" obtained from another vehicle is different from the "motion data" that Curry leverages to determine whether the driver of the vehicle in which the mobile phone is located is violating phone use permissions, or is otherwise engaged in unsafe driving behaviors. *Compare* USAA-1005, 15:24-32 *with* USAA-1005, 8:29-10:12, 13:20-14:26, Figs. 1, 3.

[1.10] the mobile telecommunications device is controlled by a downloaded application to control the mobile device to detect occurrence of a

predetermined event and in response take at least one predetermined action.

154. Curry's Fig. 1 (reproduced below), illustrates a driving safety data server 104 in wireless communication with the Curry Rabu phone. Client 110, which Curry contemplates downloading from server 104 (***downloaded application***) enables the Curry-Rabu phone to process sensor data from a driving period to derive information associated with a user's driving behavior, including whether the phone is being used while driving, and whether the user engages in behaviors such as "speeding, abnormal acceleration, abnormal deceleration, and taking sharp turns." USAA-1005, 7:5-29, 9:5-11, 8:21-9:33. Derived driving behavior information is stored in the Curry-Rabu phone, and client 110 processes the stored information both to determine a mode within which the mobile phone should operate, *Id.*, Abstract, 3:1-3:6, 7:5-22, 8:29-12:18, 13:3-19, 13:27-14:26, 16:13-18, 17:1-18:4, Figs. 1, 3, 4, 6. A POSITA would have also found it obvious to configure the client 110 to "***control***" the Curry-Rabu phone by, for example, configuring an accelerometer to record motion data during the motion recording process.

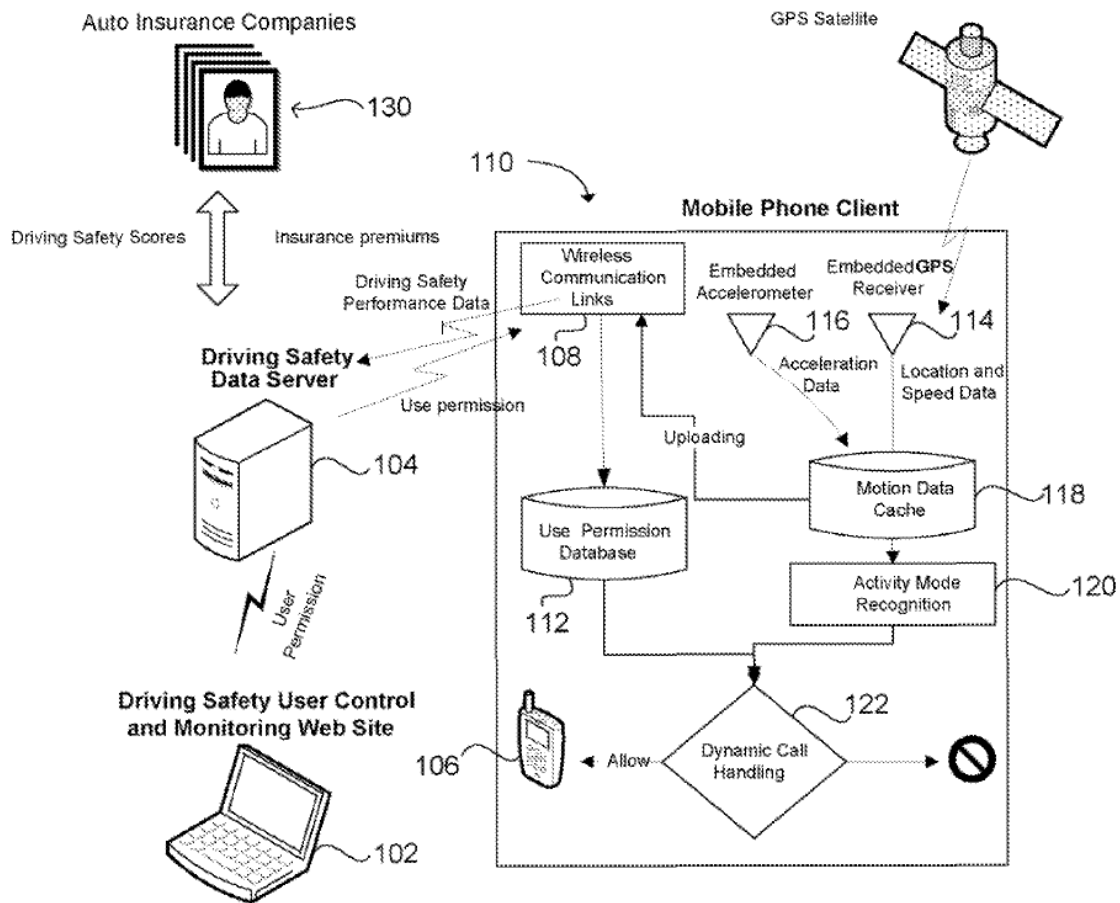


FIG. 1

USAA-1005, Fig. 1

155. Based on various embodiments of Curry, a POSITA would have found it obvious to configure the Curry-Rabu phone to detect predetermined events and to execute responsive actions, and to perform these operations on an application residing on (and downloaded to) the phone. In some embodiments, the Curry-Rabu phone detects an incoming phone call or text message while a user is driving a vehicle ("*predetermined event*"), and in response, starts to estimate

activity from a motion time series (“***predetermined action***”). USAA-1005, 16:7-22. As another example, sensor data collected by the phone is used to identify unsafe driving behaviors (“***predetermined event***”) and, in response, transmit driver safety information to server 104 (“***predetermined action***”). USAA-1005, 11:15-25. Additionally, the phone determines that a context associated with driver safety information indicates that a driver is talking or texting while driving (“***predetermined event***”) and, in response, adjusts a safety score for the driver based on the detected activity (“***predetermined action***”). *Id.*, 11:3-14.

2. *Claim 2*

[2] ***The mobile telecommunication device according to claim 1, wherein the predetermined action is storing driving information associated with that event to the memory.***

156. As discussed for [1.1] and [1.5], data collected by embedded sensors of the Curry-Rabu phone is stored in motion data cache 118 (“***storing driving information associated with that event to the memory***”), which a POSITA would have understood is one example of a predetermined action performed based on detecting unsafe driving activity or determining that a driver is talking or texting while driving. USAA-1005, 3:24-6:6, 8:30-9:3. This stored data is evaluated to identify events, such as the existence of unsafe driving behaviors (detect an “***event***”), and driving safety data is ***associated with that event.***” In some embodiments, the Curry-Rabu phone initiates the start of recording data for storage

in motion data cache 118 in response to detecting an incoming phone call or text message while a user is driving a vehicle (“*predetermined event*”). *Id.*

3. *Claim 5*

[5.1] A mobile telecommunications device according to claim 1, wherein the predetermined action comprises communicating to a remote system that an event has been detected,

157. Consistent with Curry, the Curry-Rabu phone would have been configured to determine that driver safety information is indicative of a potential unsafe driving behavior (“*event*”) and in response, transmit the driver safety information to server 104 (“*communicating to a remote system that an event has been detected*”). USAA-1005, 8:21-27, 9:23-28, 11:15-25.

[5.2] 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.

158. A POSITA would have found it obvious to implement the Curry system such that the Curry-Rabu phone receives a request from server 104 to transmit monitored information (“*request to transmit to the remote system...*”). USAA-1005, 3:2-15. Communication protocols between a mobile device and a server were well known by the Critical Date and many applications performed such communications (for example, downloading applications, requesting/receiving maps, requesting/receiving routing directions, receiving traffic information, etc.). The specific configuration of these communication

protocols was also an obvious design choice by the Critical Date because systems that enabled various types of communication between these devices were well-known by the Critical Date. Zhao (USAA-1041) is an example of a telematics systems 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. For example, Figure 2 shows a system architecture that includes a “host server” provides wireless communication with a “mobile client” once activated by a user and a request for data to be provided to the host server is received by the mobile client. *Id.* Callopy (USAA-1045) is another example of a telematics systems in which a mobile device used for monitoring 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.

159. A POSITA would have also found it obvious to configure server 104 to request portions of the data recorded by the Curry-Rabu phone (“*selected portions of the driving information*”) that are relevant to further analysis by server 104. For example, Curry describes that motion data collected by the Curry-Rabu phone can be processed by server 104 to “enable visualization of possible violations of mobile phone use or unsafe driving behavior such as speeding, abnormal deceleration and sharp turns.” USAA-1005, 9:23-28. A POSITA would

have understood from this description that one configuration of server 104 is to request the specific portions of motion data that are relevant to assessment of possible violations.

4. *Claim 9*

[9] The mobile telecommunications device according to claim 1, wherein the mobile communications device is controlled by the downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.

160. Curry's Fig. 1 (reproduced below), illustrates a driving safety data server 104 in wireless communication with the Curry Rabu phone. Client 110, which can be downloaded from server 104 (*downloaded application*) that enables the phone to process sensor data from a driving period to derive information associated with a user's driving behavior, including whether the phone is being used while driving, and whether the user engages in behaviors such as "speeding, abnormal acceleration, abnormal deceleration, and taking sharp turns." USAA-1005, 7:5-29, 9:5-11, 8:21-9:33. Derived driving behavior information is stored in the phone, and client 110 processes the stored information both to determine a mode within which the mobile phone should operate. *Id.*, Abstract, 3:1-4:6, 7:5-22, 8:29-12:18, 13:3-19, 13:27-14:26, 16:13-18, 17:1-18:4, Figs. 1, 3, 4, 6.

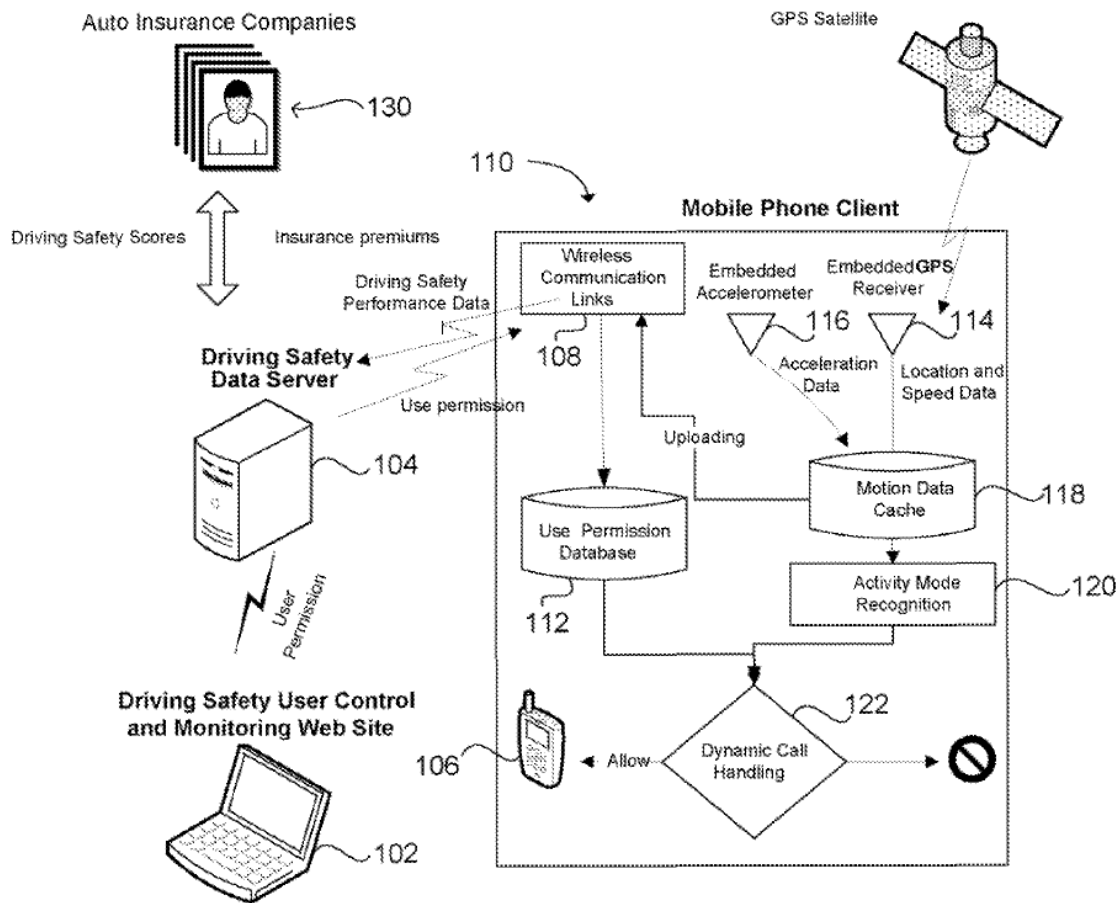


FIG. 1

USAA-1005, Fig. 1

161. As discussed for [1.7], data collected by embedded sensors of the Curry-Rabu phone is processed during a monitoring period to determine whether a vehicle is being driven safely, i.e., driver safety information (“*process the driving information*”). USAA-1005, 3:24-4:11, 7:5-22, 9:31-10:12. The driver safety information includes a safety score (“*driving score associated with a particular driver*”). The safety score is calculated based on “perform[ing] a statistical analysis

on collected raw driving data.” *Id.*, 7:5-22. Examples of safety score calculation including factoring “unsafe behaviors of talking-while-driving and texting-while-driving,” which are “associated with different point penalties.” *Id.*, 13:3-19.

Further, the safety scores can be used in different applications, such as “by consumers and insurance agencies to determine insurance premiums for related drivers” or “by parents to prevent their teenage drivers from operating a motorized vehicle while...performing [] unsafe driving actions” and “to proactively control the use of mobile devices while [] commercial vehicle drivers are operating vehicles...” *Id.*, 7:5-22.

5. *Claim 11*

[11] The mobile telecommunication device according to claim 1, wherein the predetermined action is transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system.

162. As discussed for [1.10], the Curry-Rabu phone can determine that a driver is talking or texting while driving (“***predetermined event***”). USAA-1005, 11:15-25. In response, the phone uploads driver safety information stored in motion data cache 118 to server 104 via wireless connection 108 for additional processing (“***transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system***”). USAA-1005, 7:5-22; 8:21-27, 9:23-28. As described in Curry, server 104 “can include geographic data that enables parents or commercialized vehicle companies to

specify permissible or restricted routes and time schedules for the use of calling or texting capability in a mobile phone [] when the phone is in driving mode.” *Id.*, 8:5-18. A POSITA would have found obvious that one embodiment contemplated in Curry is data recorded by a phone being evaluated by server 104 to determine whether driving activity represented by the recorded data (e.g., texting while driving) violates certain restrictions imposed on a driver. *Id.*, 8:23-29.

6. *Claim 12*

[12] The mobile telecommunication device according to claim 11, wherein the mobile telecommunications device utilizes its own power supply.

163. A POSITA would have understood and/or found obvious that the Curry-Rabu phone includes a device battery (“***power supply***”) given Curry’s non-limiting disclosure of the phone encompassing “any type of electronic mobile computing device that may be used while traveling in a vehicle.” USAA-1005, 7:23-29. Curry also references the Apple iPhone 3G smartphone, which a POSITA would have understood is an example of its phone and includes a battery. USAA-1005, 2:22-27; USAA-1079, 2; USAA-1080, 33-35. Curry also addresses techniques to reduce battery consumption, further indicating that the phone would have included a device battery. USAA-1005, 14:27-15:7 (“To reduce the power consumption, the embedded GPS receiver 314 in a mobile phone is typically turned off by default when a mobile phone is in standby mode or not is not charged”).

7. *Claim 13*

[13] *The mobile telecommunication device according to claim 11, wherein the mobile telecommunications device is a smartphone.*

164. A POSITA would have understood and/or found obvious that the Curry-Rabu phone is “a smartphone” given Curry’s non-limiting disclosure of its phone encompassing “any type of electronic mobile computing device that may be used while traveling in a vehicle.” USAA-1005, 7:23-29. Curry also recognizes that “the next generation of mobile phones” includes “cell phones, smart phones,” further reinforcing that the phone can also be implemented as a smartphone. USAA-1005, 2:22-27.

XII. [GROUND 1B] – Curry, Rabu, and Balachandran Makes Claims 3 and 4 Obvious

A. Curry-Rabu-Balachandran Combination

165. Curry’s overall focus is to improve driver safety and thereby reduce casualties resulting vehicle accidents. One way this is accomplished is through configurations in which a phone is disabled from making or receiving calls when operating in “driving mode” (i.e., when a user is driving a vehicle monitored by the phone). USAA-1005, 4:16-28. Though the phone is limited in driving mode, “selected calls, such as emergency phone calls may be allowed.” *Id.*; *see id.*, 9:16-26, cl. 9. While Curry contemplates that emergency scenarios (e.g., accidents) may occur, it does not disclose specific embodiments focused on detecting an

emergency or actions performed by the phone in response to a detected emergency. Curry instead is primarily focused on detecting unsafe driver behaviors that may result in an emergency, such as “talking on or texting with mobile phones while driving.” USAA-1005, 7:5-22.

166. Yet Curry also provides broader teachings of “programs and initiatives to reduce traffic-related fatalities and injuries.” *Id.*, 2:9-21. And, it expresses a concern for “motorized vehicle accidents and deaths[,]” which it addresses by proposing techniques that “reduce potentially catastrophic accidents for which [a] company may be responsible.” *Id.*, 11:26-12:2. A POSITA would have therefore understood that Curry provides a motivation to address unwanted accidents and deaths, including through programs and initiatives.

167. Further, given Curry’s teachings of allowing emergency calls, a POSITA looking to implement Curry would have looked to supplement its disclosure by incorporating additional emergency response techniques that were well-known by the Critical Date. As discussed in Section XII.A, Balachandran is one example disclosing a technique where an 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 modify the Curry-Rabu phone to perform Balachandran’s emergency response technique and thereby enable the phone to prevent casualties resulting from a vehicle accident.

168. A POSITA would have performed this modification since Balachandran's emergency response technique would have advanced Curry's overall motivation to reduce casualties resulting from vehicular accidents. For example, the combination would have enabled a phone to solicit emergency responses in scenarios where a vehicle accident occurs even though motion data recorded by the Curry-Rabu-Balachandran phone indicates safe driving behaviors (e.g., not texting or calling while driving). *Id.* Further, because Curry describes that the phone is capable of communicating and/or sharing safety evaluation data with other external systems (e.g., server 104, insurance company 130), a POSITA would have perceived configuring the phone to incorporate the emergency response techniques described Balachandran as an implementation detail. USAA-1005, 9:23-10:12. A POSITA would have had a reasonable expectation of success in combining Curry and Balachandran without invention as several vehicle monitoring systems by the Critical Date were similarly capable of providing emergency response techniques." USAA-1021, USAA-1022, USAA-1023.

B. Analysis of Claims 3 and 4

1. Claim 3

[3.1] The mobile telecommunications device according to claim 1, wherein the predetermined action comprises providing feedback to a user to indicate that an event has been detected,

169. 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 XII.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. 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. “After the time delay period expires[,]” the cellphone also “provides an audible indication” of “initiat[ing] [an] emergency call setup[.]” *Id.* A POSITA would have understood that notifications relating to timer 35 are used to indicate an accident has been detected since the timer 35 is specifically used to initiate an emergency call relating to a detected accident. Balachandran describes that “[t]he timer 35 provides a preselected time delay before initiating an outgoing emergency call in response to detection of a vehicle accident,” which would have led a POSITA to understand that notifications relating to timer 35 are also notifications of a detected

accident. *Id.* In the Curry-Rabu-Balachandran combination (Section XII.A), a POSITA would have found it obvious to configure the phone to provide an audio or visual output to indicate that an accident has been detected (“***providing feedback to a user***”).

170. A POSITA would have also found obvious that in some instances an accident is detected (and an audible or visual notification of the detected accident is provided) in response to the Curry-Rabu-Balachandran phone identifying an unsafe driving behavior (“***occurrence of a predetermined event***”). *Id.* Curry describes that driving behavior derived from motion data recorded by the phone can be used to determine “possible violations of mobile phone use or unsafe driving behavior.” USAA-1005, 9:23-28. With the Curry-Rabu-Balachandran combination, a POSITA would have recognized certain scenarios where unsafe driving behavior initially detected by the phone (as taught in Curry), and in response, an accident is detected as a result of that unsafe driving behavior, when then results in an audible being provided to the user (as taught in Balachandran).

[3.2] 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.

171. Balachandran’s emergency response technique involves a cellphone providing interface 45 through which “[a]n individual may cancel initiation of an emergency call...if no emergency assistance is required.” USAA-1007, 2:16-27,

4:5-21. Further, the cellphone “checks for a user abort command discontinuing the call setup procedure.” *Id.*, 4:22-31. A POSITA would have understood and/or found it obvious to implement interface 45 as a graphical user interface since Balachandran teaches that the cellphone is capable of providing a “***visual indication*** [that] notifies the passengers of activation of timer” relating to an emergency call. USAA-1007, 2:46-63. In the Curry-Rabu-Balachandran combination (*see* Section XII.A), a POSITA would have found it obvious to configure the phone to receive a user abort command relating to an emergency call (“***receive a user interaction to...deny whether the detected event has actually occurred following said feedback***”).

2. *Claim 4*

[4.1] The mobile telecommunications device according to claim 3, wherein the feedback comprises notifying a user that a further action has been scheduled, and will be taken within a predetermined period,

172. As discussed for [3.1], a POSITA would have found it obvious to configure the Curry-Rabu-Balachandran phone 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. In the Curry-Rabu-Balachandran combination (*see* Section XII.A), a POSITA would have found it obvious to configure the Curry-Rabu-Balachandran phone to notify a user that an

emergency call has been scheduled (“*a further action [that] has been scheduled*”) after a time period specified by a timer (the action “*will be taken with a predetermined period*”).

[4.2] 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.

173. As discussed for [3.2], in the Curry-Rabu-Balachandran combination (see Section XII.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. The phone 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*”).

XIII. [GROUND 1C] – CURRY, RABU, AND KATAYAMA MAKE CLAIMS 6-8 OBVIOUS

A. Curry-Rabu-Katayama Combination

174. Curry generally describes that a phone includes a motion data cache to “record data from the GPS receiver and accelerometer.” USAA-1005, 3:2-15, 3:24-4:6. Recorded data is used for “further processing[]” and that the motion data cache “can be used to store raw data for an extended period of time to provide sufficient information for a user activity mode recognition program 120.” *Id.*,

8:30-9:3. However, Curry does not address storage constraints that may be associated with recording data in the motion data cache over time and also does not disclose embodiments with specific storage configurations of the motion data cache. USAA-1005, 3:2-15, 3:24-4:6. A POSITA would have understood that such storage configurations represent implementation details that could be incorporated into Curry's disclosure without invention since storage constraints associated data collection by mobile devices were well-known by the Critical Date.

175. For example, event data recorders (EDRs) in vehicles were configured to store data for limited time periods given storage constraints in on-board memory. A POSITA would have understood that such storage constraints are no different than constraints that would typically be encountered when designing any portable system with finite memory. A POSITA would have recognized that memory is a finite resource and, as such, the amount of data that can be retained over time is limited. For example, Callopy describes a method of conserving storage space by processing raw data by "the mobile device 4005 [which] can include one or more local applications 4180 ... thereby allowing the processed data to be stored as opposed to the raw data, where it is envisioned that the processed data occupies less memory than the raw data." USAA-1045, [00330]. A POSITA looking to implement Curry would have recognized that the motion data cache has a finite storage capacity and, as a result, would have perceived a need to

supplement its disclosure with well-known data handling techniques for devices with limited storage capacities to ensure recorded data may be recorded in the motion data cache over time. In performing this search, a POSITA would have discovered Katayama, which, as discussed in Section XIII.A, describes a storage device with multiple storage sections (sections 802, 803). USAA-1024, [0044]-[0046]. Katayama also addresses storage constraints of storage device: “[i]f a capacity of the temporary data storage section 802 runs out, old data is sequentially erased and new situation data is written in the temporary data storage section 802.” *Id.*, [0045]. Further, Katayama describes the use of “judgment criterion parameters” to determine whether situation data stored in temporary data storage section 802 should be transferred to situation data recording section 803. *Id.*, [0046].

176. Katayama informs a POSITA that not only do the storage constraints of mobile devices necessitate different types of storage, but these constraints can be resolved by transferring data to permit data preservation. A POSITA would have been motivated to configure Curry’s local motion cache in a similar fashion and thereby enable the local motion cache to implement Katayama’s storage technique. *Id.* This configuration would have also improved the Curry system as it would have leveraged Katayama’s storage technique to “eliminat[e] accumulation of useless data” (as taught in Katayama). USAA-1024, [0053]. A POSITA would

have had a reasonable expectation of success in implementing this configuration since similar storage configurations were employed in mobile devices by the Critical Date.

177. For example, Del Rosso (USAA-1042) described a “dynamic memory management system” that enabled use of mobile devices in “real-time systems” where “real-time deadlines must be respected and allocations and deallocations must be done in due time.” USAA-1042, Abstract. A POSITA would have understood that a vehicle monitoring system is an example of a “real-time system” in that decisions relating to collected data (e.g., accident detection) are processed in real-time. As another example, in Callopy, the system records a time period or “a specific amount of data, e.g., the last X minutes, or until the memory capacity is exceeded, whereupon the first stored video is replaced by the most recently acquired video” and that this time “period can further be extended by insurance provider(s) 3150, such as when an accident occurs.” USAA-1045, [00255], [00327]. Callopy further describes the efficient use of memory both on the device as well as managing and transferring data (“compression and automatic back up”) off the device to remote storage areas (“a remote location (e.g., a server at an office of the company”). USAA-1045, [0039], [00244], [00268].

B. Analysis of Claims 6-8

1. Claim 6

[6.1] *The mobile telecommunications device according to claim 1, wherein the memory comprises: a long term memory for persistently storing driving information and a short term memory for transiently storing driving information,*

178. Katayama describes a recording device 1 with an information processing device 8 (“**memory**”) that includes situation data recording section 803 (“**a long term memory for persistently storing driving information**”) and temporary data storage section 802 (“**short term memory for transiently storing driving information**”). USAA-1024, [0044]-[0046], Fig. 5. In the Curry-Rabu-Katayama combination (see Section XIII.A), a POSITA would have found it obvious to configure the motion data cache of a phone to include Katayama’s situation data recording section 803 and temporary data storage section 802 as this configuration would have addressed storage constraints and also improved its storage capabilities by removing the need to accumulate useless data. USAA-1005, 8:30-9:3, 3:2-15, 3:24-4:6; USAA-1024, [0044]-[0046], [0053].

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

179. A POSITA would have understood and/or found it obvious that, in some scenarios, temporary data storage section 802 (“**short term memory**”) obtains situation data more frequently (“**receives...at a higher update rate**”) than situation

data recording section 803 (“*a long term memory*”). USAA-1024, [0044]-[0046], Fig. 5. Katayama teaches that situation data is transferred to situation data storage section 803 “[o]nly in a case that the content meets the predetermined condition...” *Id.*, [0046]. Further, “[i]f a capacity of the temporary data storage section 802 runs out, old data is sequentially erased and new situation data is written in the temporary data storage section 802.” *Id.*, [0045]. A POSITA would have understood that in scenarios where situation data is periodically recorded but no accident is detected, old data stored in temporary data storage section 802 is more frequently erased relative to situation data being transferred to situation data storage section 803.

[6.3] 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,

180. Katayama teaches “receiv[ing] the 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 802...” *Id.*, [0045]. Katayama teaches that temporary data storage section 802 records situation data (“*write driving information to the short term memory*”) at a constant sampling rate (“*at a predetermined update rate*”) and while a vehicle is monitored according to a chronological order (“*in a predetermined sequence*”). USAA-1024, [0044]-[0046], Fig. 5.

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

181. Katayama describes overwriting previously collected situation data stored in temporary data storage section 802 (“***overwrite the driving information previously written to the short term memory***”) with new situation data collected according to a constant sampling rate (“***in accordance with the predetermined sequence***”). USAA-1024, [0044]-[0046], Fig. 5. Specifically, Katayama teaches “[i]f a capacity of the temporary data storage section 802 runs out, old data is sequentially erased and new situation data is written in the temporary data storage section 802.” *Id.*, [0045].

2. *Claim 7*

[7.1] The mobile telecommunications device according to claim 6, wherein the mobile communications device is controlled by the downloaded application to control the mobile device to detect an occurrence of a predetermined event and

182. In the Curry-Rabu-Katayama combination (*see* Section XIII.A), a POSITA would have found it obvious to configure a phone to detect an accident (“***detect occurrence of a predetermined event***”) based on acceleration data and GPS data. USAA-1024, [0009], [0013], [0019].

[7.2] in response transfer data from the short term memory to the long term memory.

183. 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. 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...” USAA-1024, [0048]. A POSITA would have understood that 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. *Claim 8*

[8.1] The 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,

184. Katayama describes a set of vehicle sensors (“*external device*”) configured to 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]. In the Curry-Rabu-Katayama combination (*see* Section XIII.A), a POSITA would have found it obvious to configure a phone to obtain

data from one or more of Katayama's vehicle sensors as this configuration would have improved the accuracy of monitoring for unsafe driving behaviors. These examples are consistent with the examples of external devices described in the '487 patent specification, including "engine management system of the vehicle" and "may be arranged to connect to the on-car data network of the vehicle."

USAA-1001, 9:57-10:4.

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

185. As discussed for [8.1], the 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, in the Curry-Rabu-Katayama combination (*see* Section XIII.A), a POSITA would have similarly configured a phone to receive at least a portion of the data collected by external vehicle sensors ("***external device***").

XIV. [GROUND 1D] – CURRY, RABU, AND TAMIR MAKE CLAIM 10 OBVIOUS

A. Curry-Rabu-Tamir Combination

186. Curry describes that “[e]ach motion measurement from the GPS sensor and accelerometer can be associated with a timestamp, and stored in a local motion data cache 304 for each pre-specific sampling interval.” USAA-1005, 13:27-33. While Curry contemplates sampling intervals for motion recording process, it does not specifically address the sampling rates used for recording. A POSITA looking to implement Curry’s motion recording process would have looked to well-known data collection techniques for the types of motion data collected by the Curry system (e.g., accelerometer data, position data).

187. In doing so, a POSITA would have recognized that it was well-known by the Critical Date to employ data collection techniques in vehicle monitoring systems with variable data sampling rates. As discussed in Section XIV.A, Tamir discloses one example in which 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 Tamir’s data collection technique into the Curry system would have improved Curry’s motion recording process by, for example, allowing “lower power consumption and less wear and tear of” a phone, as taught in Tamir. USAA-1006, 20:52-21:2. Dynamic sampling rates were 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 of Claim 10

1. Claim 10

[10] The mobile telecommunication device according to claim 1, wherein the predetermined action is storing driving information captured at a higher sampling rate than when an event is not detected.

188. In the Curry-Rabu-Tamir combination (see Section XIV.A), a POSITA would have found it obvious to configure a phone to use Tamir's data collection technique to improve Curry's motion recording process using variable sampling rates. 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 understood and/or found it obvious that in scenarios in which the phone, in the combination, detects an unsafe driving behavior ("*an event*"), a higher sampling rate is used for data collection relative to other scenarios ("*driving*

information captured at a higher sampling rate than when an event is not detected”).

XV. [GROUND 2A] – Forstall, Rabu, and Langle2009 Makes Claims 1, 2, 12, 13 Obvious

A. Forstall-Rabu-Langle2009 Combination

1. Forstall and Rabu

189. 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].

190. 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.*

191. 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.

192. 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.

193. 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].

194. 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.

195. 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 it would have enabled improved detection of the device being in vehicle mode (during which the default dead reckoning mode is enabled).

196. 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.

197. 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).

198. 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.

199. 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.

200. 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*

201. As discussed in Section X.B.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]. As discussed in Section X.A.1, Curry 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.

202. Additionally, 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. 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].

203. 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, 1. 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 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, and a POSITA would have found it obvious to combine the teachings of the two references.”

204. 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

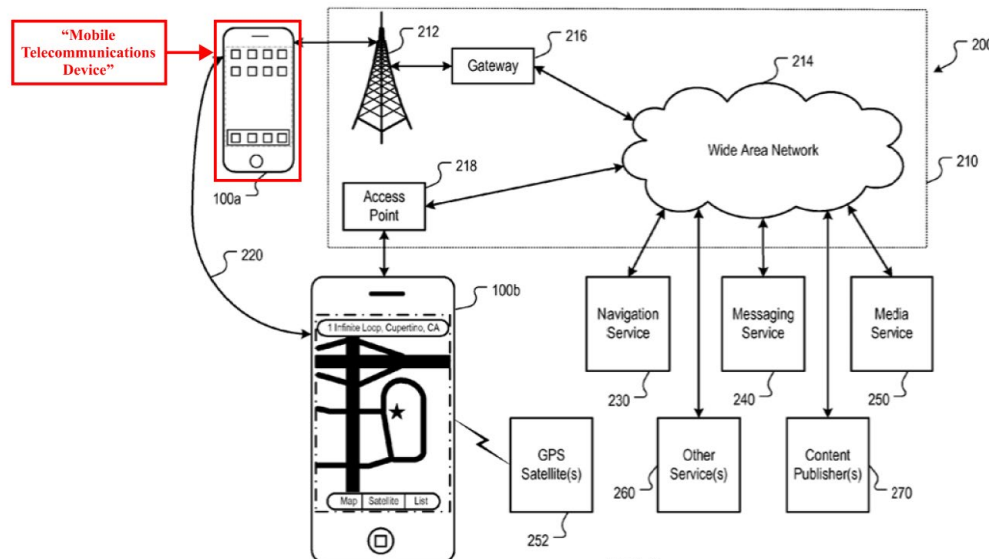
which could be used for traffic sensing functions”). As another example, Wulff (USAA-1031) discloses a mobile device that can be mounted on a vehicle and used for motion detection and vehicle monitoring. USAA-1031, [0014]-[0018].

B. Analysis of Claims 1, 2, 12, and 13

1. Claim 1

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

205. To the extent the preamble is limiting, the Curry-Rabu combination (see Section XV.A) makes it obvious. The combination includes a device (“**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.

Forstall, Fig. 2 (annotated)

206. The Forstall-Rabu-Langle2009 device 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 the Forstall-Rabu-Langle2009 device 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;

207. As shown below, the Forstall-Rabu-Langle2009 device 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].

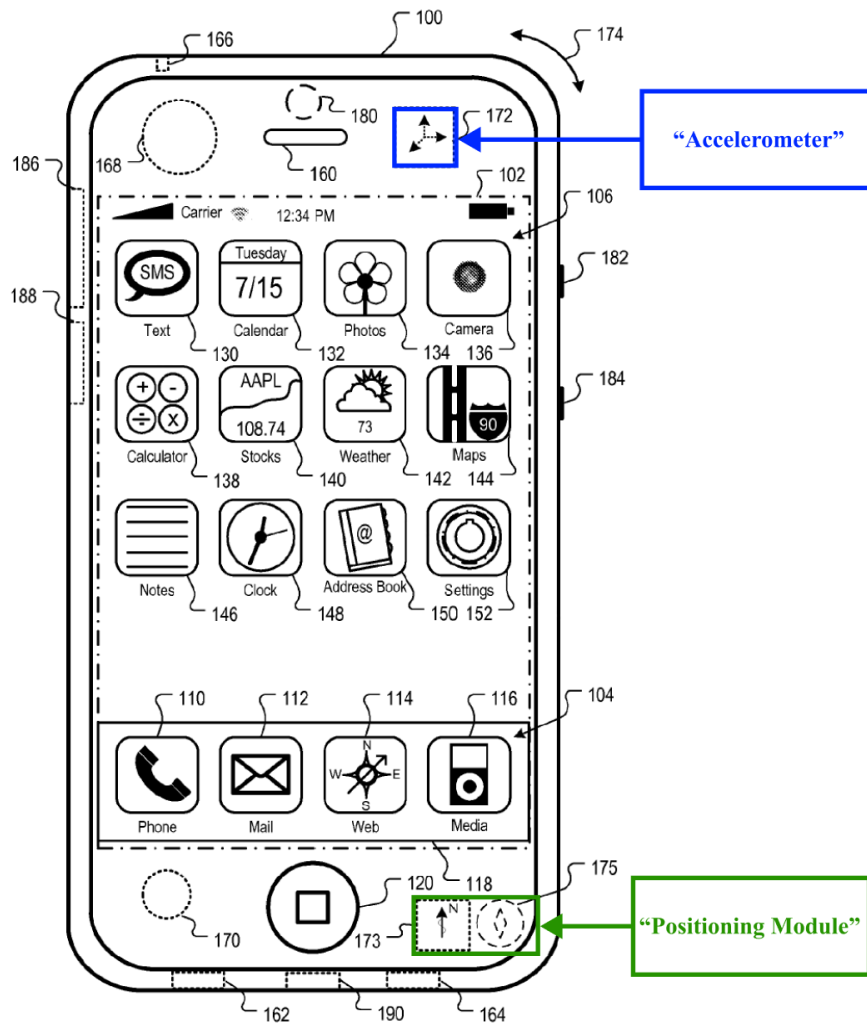


FIG. 1

Forstall, Fig. 1 (annotated)

208. Data from device's sensors is used to "measure the movement of the device [] 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 a device 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 combination (*see* Section XV.A), a POSITA would have further configured the device to process sensor data related to movement of the Forstall-Rabu-Langle2009 device to identify unsafe driving behaviors (e.g., unsafe acceleration, unsafe braking). USAA-1029, 1; USAA-1030, [0020].

[1.3] a user interface;

209. The Forstall-Rabu-Langle2009 device 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 [] from [an] origin 502 to a destination 510...” *Id.*, [0072].

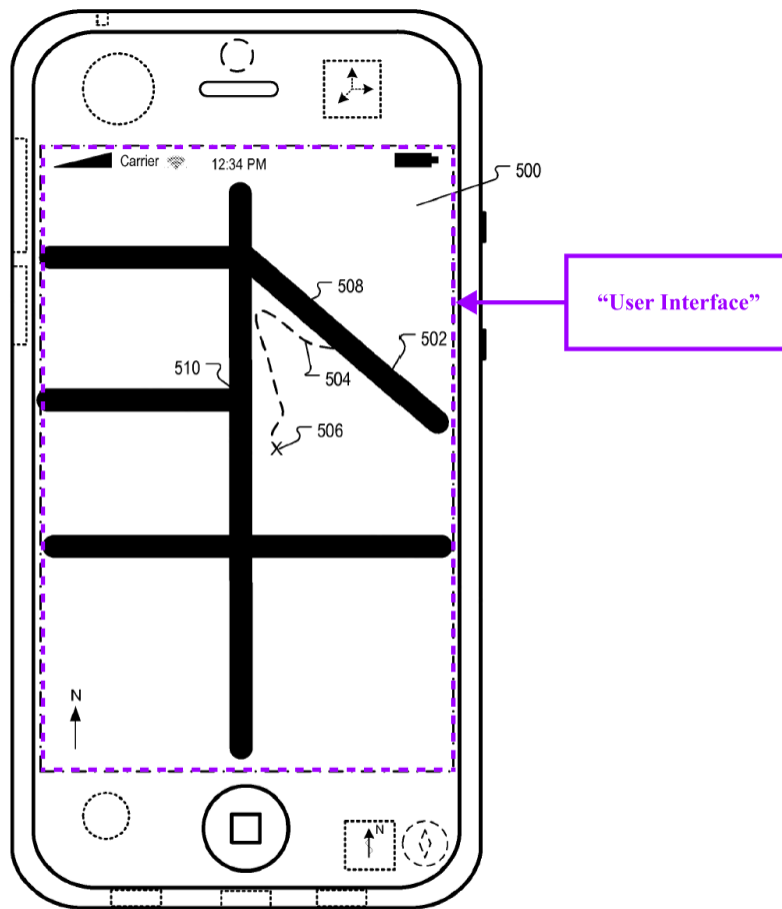


FIG. 5

USAA-1028, Fig. 5 (annotated)

Forstall discloses other examples of user interfaces in other figures. *See e.g.*, USAA-1028, Figs. 1, 4, 7.

[1.4] a processor; and

210. The Forstall-Rabu-Langle2009 device 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 the sensor data as movement of the device 100[,]” and “determine velocity, and position[,]” and/or a direction of travel. *Id.*

[1.5] a memory;

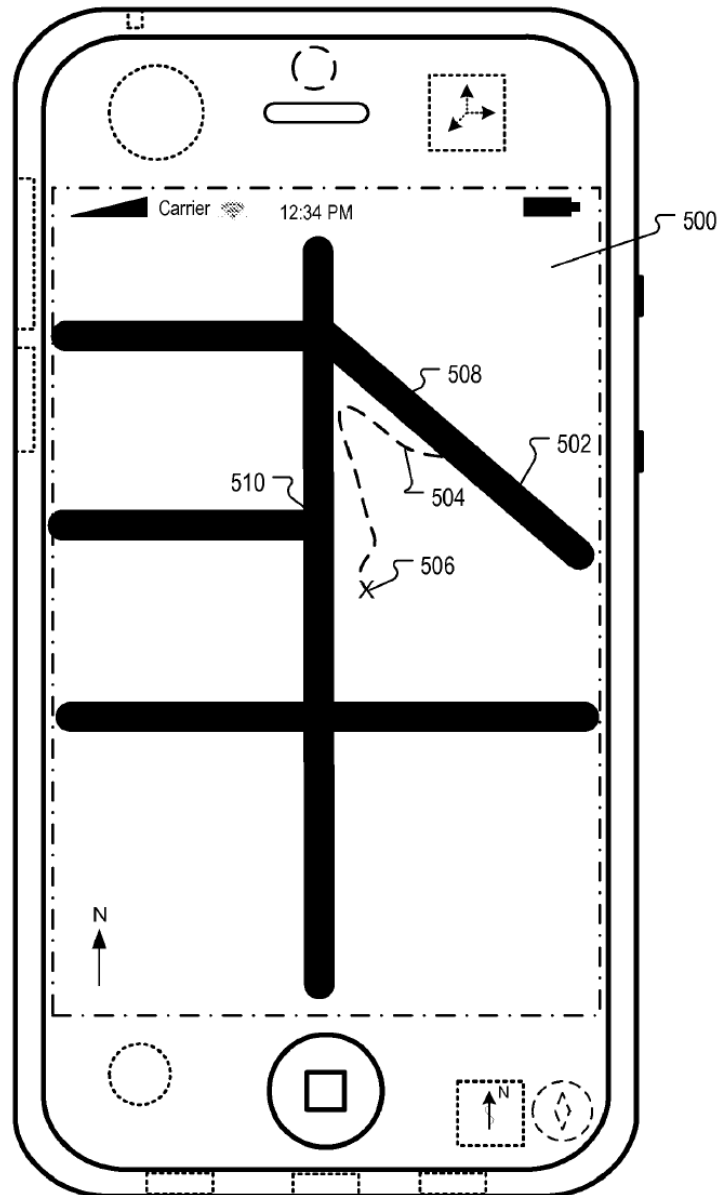
211. The Forstall-Rabu-Langle2009 device includes memory (“**memory**”) for storing information relating to “adaptive mobile device navigation,” such as “a device position.” USAA-1028, [0006]. In one exemplary embodiment, the device includes “memory 350” that includes “high-speed random access memory 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.*

212. 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 found it obvious to configure memory of the Forstall-Rabu-

Langley2009 device 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 configured to: determine, based on 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;

213. As previously discussed, “driving period” is not limited to a start of the vehicle being driven, and the determination of the start of driving period need not be based on concurrent use of (1) “the inputs received by the user interface and sensor data” and (2) “sensor data from the device’s sensor set.” As discussed in Section X.B.1, Forstall describes that its device 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]. 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

214. 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 the device 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 [] request[ing] and receiv[ing] a map for the location ‘1 Infinite Loop, Cupertino, Calif.’” USAA-1028, [0042].

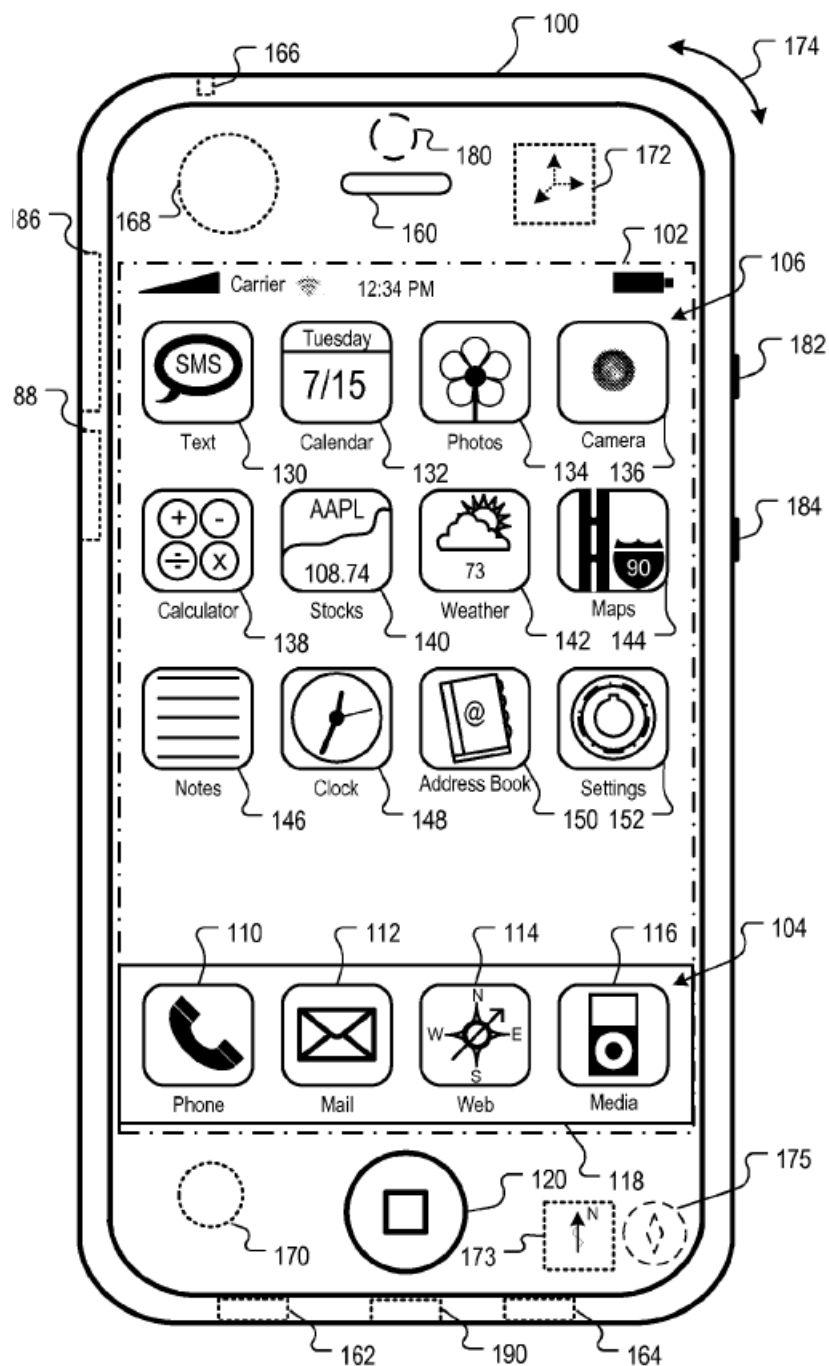
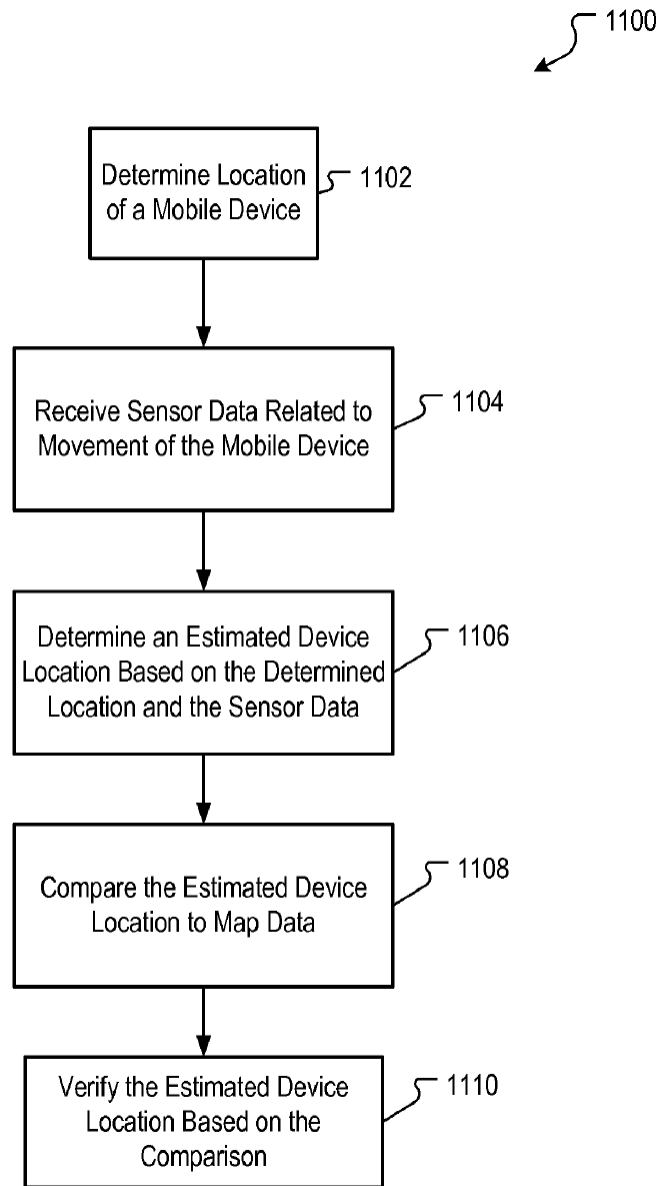


FIG. 1

USAA-1028, Fig. 1

215. 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 of the Forstall-Rabu-Langle2009 device (“*sensor data from the device’s sensor set*”), for example, when the device 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

216. 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].

217. Moreover, a POSITA would have combined Forstall and Rabu by configuring device to be “mounted in a vehicle” using an “automobile dock” or “vehicle holder,” and 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 XV.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 the Forstall-Rabu-Langle2009 device using a “dock status” that indicates attachment to “automobile dock” or “vehicle holder” (as taught in Rabu). The detection of a “dock status” would enable the device 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. A POSITA would have also understood that such a configuration would have been useful increase the visibility of information (e.g., driving

instructions) shown through the navigation application since the “dock status” could be have been used by the Forstall-Rabu-Langle2009 device to determine when a user is ready to start driving the vehicle.

[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;

218. As discussed for [1.2], a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009 device to collect sensor data related to movement of the device from its integrated sensors (“***sensor data from the sensor set***”) while a navigation application is running on the device and used to 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 that indicates safe and unsafe driving behaviors (“***driving information associated with how the vehicle is driven***”). USAA-1029, 1 (“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 [brakes]”), 2-3, Figs. 2, 4.

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

219. As discussed for [1.2], a POSITA would have found it obvious to configure the memory of the Forstall-Rabu-Langle2009 device (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 have 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.

220. Additionally, a POSITA would have recognized that storing a selection of driving safety data in smartphone memory was a well-known technique by the Critical Date. USAA-1042, Abstract. For example, Callopy shows “the automobile insurance industry” goal to “collect and 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 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-1041 [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.” *Id.*, [00330].

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

221. As discussed for [1.7], driving safety data (“***driving information***”) is determined based on evaluating sensor data collected by integrated sensors of the Forstall-Rabu-Langle2009 device (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, 1-2; USAA-1031, [0010].

[1.10] the mobile telecommunications device is controlled by a downloaded application to control the mobile device to detect occurrence of a predetermined event and in response take at least one predetermined action.

222. Forstall describes examples of display objects used to access applications on a mobile device and further describes that its device “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 the Forstall-Rabu-Langle2009 device (“***downloaded application***”). USAA-1028, [0042], Fig. 5. As discussed in Section XV.A, the navigation application monitors location information on the Forstall-Rabu-Langle2009 device such that it is “***controlled***” by the navigation application while a user accesses map data. *Id.*, [0030]-[0033], [0042].

223. As discussed for [1.7], a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009 device to classify driving behaviors based on sensor data, such as unsafe acceleration and unsafe braking. USAA-1029, 1. A POSITA would have understood detection of a particular driving behavior to represent “***detect occurrence of a predetermined event***” since the detected behaviors are among a finite number of predetermined classifications described in Langle (e.g., unsafe acceleration, unsafe braking). *Id.* Further, Langle describes that “to enhance and strengthen [] emergency services, mobile phones may be used to aid in safe driving practices and detection of emergencies.” USAA-1029, 1. A POSITA would have found it obvious that in at least some configurations of the combination, detection of an unsafe driving behaviors results in initiating access to emergency services (“***take at least one predetermined action***”). For example, a

POSITA would have found it obvious to configure the device to use well-known emergency services (e.g., sending a notification to an emergency provider) in response to detecting an unsafe acceleration/deceleration indicating that a user may be in danger. USAA-1023; USAA-1046.

2. *Claim 2*

[2] The mobile telecommunication device according to claim 1, wherein the predetermined action is storing driving information associated with that event to the memory.

224. As discussed for [1.5] and [1.8], a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009 device 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, 6. 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.**” A POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009 device to initiate the start of collecting safety data in response to detecting unsafe acceleration and unsafe braking (“**predetermined event**”). Such a configuration would have been obvious because it would have limited the collection of data by the device to information most relevant to “aid in safe driving practices and detection of emergencies.” USAA-1029, 1.

3. *Claim 12*

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

225. The Forstall-Rabu-Langle2009 device 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 found obvious that the device 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 as their own power supplies. USAA-1043, 109-13. For example, Wakihara (USAA-1043) discussed recent developments in lithium ion batteries in 2001 that a POSITA would have recognized are applicable to mobile devices. *Id.*

4. *Claim 13*

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

226. As discussed for [1.1], the Forstall-Rabu-Langle2009 device can be a “smartphone” and “can place and receive phone calls (e.g., using VoIP protocols)[.]” USAA-1028, [0024], [0040].

XVI. [GROUND 2B] – FORSTALL, RABU, LANGLE2009, AND BALACHANDRAN MAKE CLAIMS 3 AND 4 OBVIOUS

A. Forstall-Rabu-Langle2009-Balachandran Combination

227. As discussed in Section X.A.3, 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 existing combination and thereby enable the Forstall-Rabu-Langle2009-Balachandran device to prevent casualties resulting from a vehicle accident.

228. A POSITA would have been motivated to apply Balachandran's emergency response technique to reduce casualties resulting from vehicular accidents, as taught in Langle. For example, the Forstall-Rabu-Langle2009-Balachandran 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 expectation of success in implementing the Forstall-Rabu-Langle2009-Balachandran combination without invention since "several vehicle monitoring systems by the Critical Date were similarly capable of providing emergency response techniques." USAA-1021, USAA-1022, USAA-1023.

B. Analysis of Claims 3 and 4

1. Claim 3

[3.1] 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,

229. As discussed in Section XVI.A, Balachandran describes sensors that detect an accident (“*an event [that] has been detected*”). USAA-1007, 2:16-27, 4:5-21. 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. 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. “After the time delay period expires[,]” the cellphone also “provides an audible indication” of “initiat[ing] [an] emergency call setup[.]” *Id.* A POSITA would have understood that notifications relating to timer 35 are used to indicate an accident has been detected since the timer 35 is specifically used to initiate an emergency call relating to a detected accident. Balachandran describes that “[t]he timer 35 provides a preselected time delay before initiating an outgoing emergency call in response to detection of a vehicle accident,” which would have led a POSITA to understand that notifications relating to timer 35 are also notifications of a detected accident. *Id.* Since

notifications such as an emergency call being placed when an accident is detected are already part of the combination, a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Balachandran device to make the minor addition of also providing an audio or visual output to indicate that an accident has been detected (“*providing feedback to a user*”).

230. A POSITA would have also found obvious that in some instances an accident is detected (and an audible or visual notification of the detected accident is provided) in response to the Forstall-Rabu-Langle2009-Balachandran device identifying an unsafe driving behavior (“*occurrence of a predetermined event*”).

Id. Langle recognizes that “mobile phones may be used to aid in safe driving practices and detection of emergencies,” which advances the “world to continue[] to enhance and strengthen its emergency services[.]” USAA-1029, 1. With the Forstall-Rabu-Langle2009-Balachandran combination, a POSITA would have recognized certain scenarios where unsafe driving behavior initially detected by the device (as taught in Langle2009), and in response, an accident is detected as a result of that unsafe driving behavior, when then results in an audible being provided to the user (as taught in Balachandran).

[3.2] 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.

231. Balachandran's emergency response technique involves a cellphone providing interface 45 through which "[a]n individual may cancel initiation of an emergency call...if no emergency assistance is required." USAA-1007, 2:16-27, 4:5-21. Further, the cellphone "checks for a user abort command discontinuing the call setup procedure." *Id.*, 4:22-31. A POSITA would have understood and/or found it obvious to implement interface 45 as a graphical user interface since Balachandran teaches that the cellphone is capable of providing a "***visual indication*** [that] notifies the passengers of activation of timer" relating to an emergency call. USAA-1007, 2:46-63. A POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Balachandran device to receive a user abort command relating to an emergency call ("***receive a user interaction to...deny whether the detected event has actually occurred following said feedback***").

2. *Claim 4*

[4.1] The mobile telecommunications device according to claim 3, wherein the feedback comprises notifying a user that a further action has been scheduled, and will be taken within a predetermined period,

232. As discussed for [3.1], a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-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. The device, as configured, would have notified a user that an emergency call has been scheduled (“*a further action [that] has been scheduled*”) after a time period specified by a timer (the action “*will be taken with a predetermined period*”).

[4.2] 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.

233. As discussed for [4.2], a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Balachandran device to receive a user abort command relating to an emergency call. USAA-1006, 2:64-3:6, 4:22-31. The device, as configured, would have received 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*”).

XVII.[GROUND 2C] – FORSTALL, RABU, LANGLE2009, AND KATAYAMA MAKE CLAIMS 6-8 OBVIOUS

A. Forstall-Rabu-Langle2009-Katayama Combination

234. A POSITA would have understood that memory of the Forstall-Rabu-Langle2009 device (a mobile device) has a finite storage capacity. Moreover, since the type of vehicle monitoring disclosed in Langle2009 involves periodically

accumulating sensor data on a mobile device, a POSITA would have perceived a need to address storage constraints on the mobile device and thereby looked to well-known data handling techniques for devices. This would have provided a configuration that supports ongoing collection and storage of sensor data in the Forstall-Rabu-Langle2009-Katayama device without necessitating, for example, upgrades to storage capacity on the device or impediments to subsequent data collection when the storage is full. Katayama (*see* Section XVII.A), which describes a storage device with multiple storage sections (sections 802, 803). USAA-1024, [0044]-[0046].

235. A POSITA would have understood that Katayama not only recognizes that storage constraints of mobile devices necessitate different types of storage, but further discloses a technique for transferring data to permit data preservation despite the storage constraints. A POSITA would have been motivated to configure the Forstall-Rabu-Langle2009-Katayama device's memory in a similar fashion and thereby enable the memory to take advantage of Katayama's storage technique. *Id.* This configuration would have also improved the existing combination as it would have leveraged Katayama's storage technique to "eliminat[e] accumulation of useless data" (as taught in Katayama). USAA-1024, [0053]. A POSITA would have had a reasonable expectation of success in implementing this configuration since similar storage configurations were employed in mobile device-based vehicle

monitoring systems by the Critical Date. USAA-1042, Abstract. This is demonstrated in Callopy wherein the system records a time period or “a specific amount of data, e.g., the last X minutes, or until the memory capacity is exceeded, whereupon the first stored video is replaced by the most recently acquired video” and that this time “period can further be extended by insurance provider(s) 3150, such as when an accident occurs.” USAA-1045, [00255], [00327]. Callopy further describes the efficient use of memory both on the device as well as managing and transferring data (“compression and automatic back up”) off the device to remote storage areas (“a remote location (e.g., a server at an office of the company”). *Id.*, [0039], [00244], [00268].

B. Analysis of Claims 6-8

1. Claim 6

[6.1] The 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,

236. Katayama describes a recording device 1 with an information processing device 8 (“***memory***”) that includes situation data recording section 803 (“***a long term memory for persistently storing driving information***”) and temporary data storage section 802 (“***short term memory for transiently storing driving information***”). USAA-1024, [0044]-[0046], Fig. 5. In the Forstall-Rabu-Langle2009-Katayama combination (*see* Section XVII.A), a POSITA would have

found it obvious to configure the memory of the Forstall-Rabu-Langle2009-Katayama device to include Katayama's situation data recording section 803 and temporary data storage section 802. This configuration would have addressed storage constraints and also improved its storage capabilities by removing the need to accumulate useless data. USAA-1024, [0044]-[0046], [0053]; USAA-1028.

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

237. A POSITA would have understood and found it obvious that, in some scenarios, temporary data storage section 802 ("***short term memory***") obtains situation data more frequently ("***receives...at a higher update rate***") than situation data recording section 803 ("***a long term memory***"). USAA-1024, [0044]-[0046], Fig. 5. Katayama teaches that situation data is transferred to situation data storage section 803 "[o]nly in a case that the content meets the predetermined condition..." *Id.*, [0046]. Further, "[i]f a capacity of the temporary data storage section 802 runs out, old data is sequentially erased and new situation data is written in the temporary data storage section 802." *Id.*, [0045]. A POSITA would have understood that in scenarios where situation data is periodically recorded but no accident is detected, old data stored in temporary data storage section 802 is more frequently erased relative to situation data being transferred to situation data storage section 803.

[6.3] 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,

238. Katayama teaches that the temporary data storage section 802 records situation data (“***write driving information to the short term memory***”) at a constant sampling rate (“***at a predetermined update rate***”) and while a vehicle is monitored according to a chronological order (“***in a predetermined sequence***”). USAA-1024, [0044]-[0046], Fig. 5. Specifically, Katayama teaches “receiv[ing] the 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 802...” *Id.*, [0045].

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

239. Katayama describes overwriting previously collected situation data stored in temporary data storage section 802 (“***overwrite the driving information previously written to the short term memory***”) with new situation data collected according to a constant sampling rate (“***in accordance with the predetermined sequence***”). USAA-1024, [0044]-[0046], Fig. 5. Specifically, Katayama teaches “[i]f a capacity of the temporary data storage section 802 runs out, old data is sequentially erased and new situation data is written in the temporary data storage section 802.” *Id.*, [0045].

2. *Claim 7*

[7.1] 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

240. As discussed for [1.10] (*see* Section XVII.A), a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Katayama device 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, 1; USAA-1030, [0051].

[7.2] in response transfer data from the short term memory to the long term memory.

241. 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]. A POSITA would have understood that 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. *Claim 8*

[8.1] The 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,

242. 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]. In the Forstall-Rabu-Langle2009-Katayama combination (*see* Section XVII.A), a POSITA would have found it obvious to configure its device to obtain data from vehicle sensors as this configuration would have improved the accuracy of monitoring for unsafe driving behaviors. These examples are consistent with the examples of external devices described in the ’487 patent specification, including “engine management system of the vehicle” and “may be arranged to connect to the on-car data network of the vehicle.” USAA-1001, 9:57-10:4.

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

243. As discussed for [17.1], the 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-Katayama device to receive at least a portion of the data collected by external vehicle sensors (“***external device***”).

XVIII. [GROUND 2D] – FORSTALL, RABU, LANGLE2009, AND WARREN MAKE CLAIMS 5, 9, 11 OBVIOUS

A. Forstall-Rabu-Langle2009-Warren Combination

244. As previously discussed, Langle2009 describes techniques to improve driver safety by evaluating accelerometer data to identify unsafe driving behaviors. USAA-1029, 1. 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, 1. 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.

245. By the Critical Date, one common and well-known technique of improving driver safety is by numerically representing how safe or unsafe certain driving behaviors were based on evaluating recorded sensor data. USAA-1044. For example, Toledo (USAA-1044) is a December 2007 publication focused on using in-vehicle data recorders for monitoring and feedback on driver behavior and disclosed computing an “[i]ndividual risk index,” which is “a numeric measure that aims to indicate the driver’s risk of involvement in car crashes in a given period of time.” USAA-1044, 323. With this knowledge, a POSITA would have looked to incorporate the use of such techniques into the existing combination as this would improve Langle2009’s focus on “classify[ing] driving habits as safe or unsafe.” USAA-1029, 1. For instance, numerical scores would have enabled the Forstall-Rabu-Langle2009-Warren 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.

246. 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 existing 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, 1. 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, 1; USAA-1030, [0020]. Additionally, 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.

B. Analysis of Claims 5, 9, 11

1. Claim 5

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

247. Warren discloses a central system 170 (“**remote system**”) that receives data collected and/or generated for a monitored vehicle. USAA-1030, [0021].

Warren describes sending monitored data to central system 170 for processing. *Id.*

In the Forstall-Rabu-Langle2009-Warren combination (*see* Section XVIII.A), a POSITA would have found it obvious to configure its device to detect an unsafe acceleration from driving safety data (detect an “*event*”) and provided the driving safety data to Warren’s central system 170 (“*communicating to a remote system that an event has been detected*”). USAA-1029, 1; USAA-1030, [0022], [0038], [0051]. A POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Warren device to provide the driving safety data to Warren’s central system 170 in response to detecting unsafe acceleration and unsafe braking (“*predetermined event*”). Such a configuration would have been obvious since it would have enabled the transmission of data most relevant to “aid in safe driving practices and detection of emergencies.” USAA-1029, 1.

[5.2] *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.*

248. In the combination (*see* Section XVIII.A), a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Warren device to receive a request from Warren’s central system 170 to transmit driving safety data (“*request to transmit to the remote system...*”). USAA-1030, [0022], [0023].

Communication protocols between a mobile device and a server were well known by the Critical Date and many applications performed such communications (for example, downloading applications, requesting/receiving maps,

requesting/receiving routing directions, receiving traffic information, etc.). The specific configuration of these communication protocols was also 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 systems 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 systems in which a mobile device used for monitoring 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.

249. A POSITA would have also found it obvious to configure central system 170 to request portions of the safety data collected by the Forstall-Rabu-Langle2009-Warren device (“*selected portions of the driving information*”) that is relevant to further analysis by central system 170. For example, Warren describes that “data is received by the central system 170” to “generate driver score[,]” which is “based in part on the data collected by the vehicles and provided to the central system 170.” USAA-1030, [0023]. Warren also describes that “data recording system 140 operates to filter the data available from the data collection

interfaces and only provide the necessary information to the central system [170].”
Id., [0020]. A POSITA would have understood from these descriptions that one configuration of central system 170 is to request the specific portions of safety data that are relevant to generate a driver score based on driving activity.

2. *Claim 9*

[9] The mobile telecommunications device according to claim 1, wherein the mobile communications device is controlled by the downloaded application to control the mobile device to process the driving information to generate a driving score associated with a particular driver.

250. As discussed in Section XVIII.A, a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Warren device to determine a driver score based on the driving safety data (“***driving 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 found it obvious to configure the Forstall-Rabu-Langle2009-Warren device 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, 1-2; 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].

3. *Claim 11*

[11] The mobile telecommunication device according to claim 1, wherein the predetermined action is transmitting driving information via a wireless telecommunication module of the mobile telecommunication device to a remote system.

251. As discussed for [5.1], 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 its device 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]. In the Forstall-Rabu-Langle2009-Warren combination (*see* Section XVIII.A), a POSITA

would have found it obvious to configured its device 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”*).

XIX. [GROUND 2E] – FORSTALL, RABU, LANGLE2009, AND TAMIR MAKES CLAIM 10 OBVIOUS

A. Forstall-Rabu-Langle2009-Tamir Combination

252. A POSITA would have recognized that incorporating Tamir’s data collection technique into the existing combination would have improved motion recording by, for example, allowing “lower power consumption and less wear and tear of” phone 100. USAA-1006, 9:10-20, 20:52-21:11, 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 of Claim 10

1. Claim 10

[10] The mobile telecommunication device according to claim 1, wherein the predetermined action is storing driving information captured at a higher sampling rate than when an event is not detected.

253. As discussed in Section XIX.A, a POSITA would have found it obvious to configure the Forstall-Rabu-Langle2009-Tamir device 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 found it obvious to configure the Forstall-Rabu-Langle2009-Tamir device to detect an unsafe driving behavior ("**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**"). A POSITA would have also found it obvious to configure the device to initiate the start of collecting safety data in response to detecting unsafe acceleration and unsafe braking ("**predetermined event**"). Such a configuration would have been obvious because it would have limited the collection of data by the device to

information most relevant to “aid in safe driving practices and detection of emergencies.” USAA-1029, 1.

XX. CONCLUSION

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

255. 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.

256. 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.

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.

Accelaron 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.
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3.3 Book Chapters

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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.

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“*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)

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- [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