

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Martin Koebler, et al.
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Title: ELECTRIC VEHICLE POWER MANAGEMENT SYSTEM

DECLARATION OF DR. VASSILIOS MORELLAS

I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

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: 02/01/2024

By: _____

Vasilios Morellas

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I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. My education and experience are described more fully in the attached curriculum vitae. For ease of reference, I have highlighted certain information below.

2. I am currently employed as a Research Professor of Electrical and Computer Engineering at the University of Minnesota, Twin Cities, Minnesota. I am currently also the Director of the National Science Foundation (“NSF”) Center on Robots & Sensors for Human Well Being at the University of Minnesota.

3. I believe that I am well qualified to serve as a technical expert in this matter based upon my educational and work experience.

4. I have been involved with the design and evaluation of computer vision systems, sensors, lasers for various automation tasks, for approximately 30 years. My academic research has been in the areas of computer vision, robotics, intelligent transportation systems, sensor networks, object recognition, and sensor-based control in transportation systems. I have also been involved in work since 1995 involving computer algorithms for vehicle tracking, camera calibration, inspection, object recognition, vehicle monitoring systems, and motion control devices. I have authored or co-authored a book and book chapters and numerous peer-reviewed technical papers in these areas. My curriculum vitae details my

degrees, employment history, teaching experience, publication list, scholarly accomplishments, professional contributions, grants, honors, and awards.

5. I received my Diploma of Engineering in Mechanical Engineering from the National Technical University of Athens in Greece in 1983. I obtained my Master of Science degree in Mechanical Engineering from the Columbia University in New York, New York in 1989. In 1995, I received my Ph.D. in Mechanical Engineering from the University of Minnesota. My research at the time was in robotics, computer vision and control, computer integrated manufacturing, and software engineering, and my Ph.D. thesis was titled “A Neuro-computational Mobile Robot Architecture for Mapping Localization and Navigation.” The work revolved around the use of neural networks and a suite of ultrasonic sensors to accomplish place recognition and autonomous navigation for a mobile robot.

6. After receiving my Doctorate degree, from 1995-1998, I was employed as a Research Associate at the Department of Mechanical Engineering at the University of Minnesota. My work as a research associate concerned autonomous driving of a tractor trailer using a combination of cameras, Differential Geographic Position Systems (DGPS), and magnetometers along with speed and steering control algorithms to achieve autonomous navigation.

Autonomous driving of this vehicle was successfully demonstrated at a testing facility of the Minnesota Department of Transportation (MnDOT).

7. Starting in 2003, and until 2014, I was an instructor at the Department of Mechanical Engineering at the University of Minnesota. As an instructor, I taught classes related to robotics and computer vision. I also conducted research and oversaw projects directed to camera-based security and surveillance. Network camera surveillance and tracking was field deployed at Philadelphia's train station.

8. From 2019 until the present, I have served as a Research Professor of Electrical and Computer Engineering at the University of Minnesota. While in this role, I have advised and mentored students related to image-based cancer recognition, precision agriculture automation, and vision-based techniques for early detection of autism spectrum disorders. I have mentored and advised student research related to Computer Vision, Artificial Intelligence, Algorithms and Data Structures, and Readings in Computational Vision. These cover a variety of topics that include 3D reconstruction, extraction of depth, inspection, tracking, light striping, lasers, structured light, structure from motion, occlusions, edge detection, and basic image processing. My academic research has continued in the fields of computer vision systems, sensors, and lasers, with primary specialties in robotics, intelligent transportation systems, and sensor-based control in transportation applications.

9. From 2006-2019, I was the Program Director of the Computer Science & Engineering of the University of Minnesota. While in this role, I continued research on various types of automation involving the integration of sensors of different modalities with electro-mechanical platforms.

10. I have received research grants for various projects involving computer vision as applied to the transportation industry, including the development of a camera-based solution to the Truck Parking Availability problem that uses 3D reconstruction of truck park stops.

11. In terms of my industrial experience, from 1998-2005, I was employed as a Principal Research Scientist, in the Advanced Technology Labs of Honeywell International Inc. From 2005-2006, I was employed as a Senior Principal Research Scientist, also in the Advanced Technology Labs of Honeywell. During my time at Honeywell, my work was primarily concerned with systems that enhanced security and surveillance. The pinnacle of this work was a demonstration of secure gate access of vehicles at a naval base, using a custom developed multi-spectrum camera and face recognition technologies.

12. From 2007-2014, I served as a Co-PI for the NSF Research Center on Safety, Security and Rescue at the University of Minnesota. While there, I was tasked with directing the University of Minnesota site research on various research

topics of interest to industrial partners that chose to join our center paying an annual fee.

13. From 2014 until the present, I have acted as the Director of the NSF center on Robots & Sensors for Human Well Being at the University of Minnesota. In this role, my work concerns organizing the center's activities attracting industrial financial support and directing research in intelligent transportation, medical research (cancer recognition, mental health disorders), precision agriculture, and robotics.

14. I am listed as an inventor on numerous patents issued in the United States and foreign countries. My inventions concern technologies including computer and machine vision technologies. Examples of my issued U.S. patents include:

- US Pat. No. 9,858,816, titled "Determining Parking Space Occupancy Using a 3D Representation"
- US Pat. No. 7,907,750, titled "System and Method for Autonomous Object Tracking"
- US Pat. No. 7,602,942, titled "Infrared and Visible Fusion Face Recognition System"
- US Pat. No. 7,149,325, titled "Cooperative Camera Network"

- US Pat. No. 7,806,604, titled “Face Detection and Tracking in a Wide Field of View”
- US Pat. No. 7,606,425, titled “Unsupervised Learning of Events in a Video Sequence”

15. I have authored or co-authored over 130 articles or conference presentations, including numerous papers and presentations concerning computer or machine vision technologies. Of particular interest may be the following papers and presentations:

- Video Analytics for Security and Transportation Applications, Keynote talk at the 4th IEEE Computer Vision and Pattern Recognition Workshop on Object Tracking & Classification Beyond the Visible Spectrum (OTCBVS 2007), June 22, 2007
- Between the Lines: A Driver-Assistive Technology for Staying in the Lane, GPS World, Vol. 9, 1988
- Accurate 3D ground plane estimation from a single image, IEEE International Conference on Robotics and Automation, 200

16. I have been actively involved in multiple technical communities, including the IEEE Society, and NSF Review panels. I have served in the organizing committee of many technical conferences, including, for example:

- Associate Editor, IEEE/RSJ International Conference on Intelligent Robots and Systems, 2019
- Technical Committee, 22nd International Conference on Pattern Recognition, ICPR 2014
- Program Area Chair, 5th IEEE International Conference on Advanced Video and Signal Based Surveillance, 2008

17. My research has been recognized by multiple organizations, universities, and institutions. The following is a small set of honors and awards that I have received:

- Center for Transportation Studies: CTS Research Partnership Award, 2016
- Best Student Paper Award, IEEE International Conference on Image Processing (ICIP), 2012
- Technical Achievement Award, for Technical Excellence in the area of “People Tracking in Camera Networks”, Highest Honorary Distinction from Automation and Control Solutions (ACS) of Honeywell International Inc., April 2003.

18. Overall, I have used my education, industry, teaching, writing, and membership and service experiences and my understanding of the knowledge, creativity, and experience of a person having ordinary skill in the art in forming the opinions.

19. My extensive experience in the transportation industry is applicable to analyzing the Asserted Patents.

20. I have been retained on behalf of Tesla, Inc. to offer technical opinions relating to U.S. Patent No. 10,883,399 (“the ’399 patent”) and prior art references relating to its subject matter. I have reviewed the ’399 patent, and relevant excerpts of the prosecution history of the ’399 patent. I have also reviewed the following references:

- U.S. Patent No. 10,882,399 to Koebler, et al. (“the ’399 Patent”) (TESLA-1001)
- Excerpts from the Prosecution History of the ’399 patent (“the Prosecution History”) (TESLA-1002)
- Complaint, iQar Inc. v. Tesla, Inc., 1:23-cv-00694, W.D. Tex., June 20, 2023 (TESLA-1004)
- Certified Translation of Japanese Pat. Pub. No. JP 2003-276472 (“Hongo”) (TESLA-1005)
- Translation Certification for TESLA-1005 (TESLA-1006)
- Japanese Pat. Pub. No. JP 2003-276472 (“Hongo2”) (TESLA-1007)
- U.S. Pat. No. 6,282,464 (“Obradovich”) (TESLA-1008)
- U.S. Pat. No. 7,059,435 (“Niki”) (TESLA-1009)
- U.S. Pat. App. Pub. No. US 2005/0251325 (“Kudo”) (TESLA-1010)

- U.S. Pat. No. 6,314,347 (“Kuroda”) (TESLA-1011)
- U.S. Pat. No. 7,552,008 (“Newstrom”) (TESLA-1012)
- U.S. Pat. No. 8,229,644 (“Boecker”) (TESLA-1013)
- U.S. Pat. No. 6,420,975 (“DeLine”) (TESLA-1014)
- Trach, Walter, Jr. et al., “Driver Assistive Systems for Rural Applications: Digital Mapping of Roads for Lane Departure Warnings (“Trach”) (TESLA-1015)
- Mukhachev P. A. et al., “Modern Machine Learning Methods for Telemetry-Based Spacecraft Health Monitoring,” Automation and Remote Control, 2021, Vol. 82, No. 8, pp. 1293–1320 (2021) (TESLA-1016)
- Gorjestani A. et al., “Radar Based Longitudinal Virtual Bumper Collision Avoidance System Implemented on a Truck” (Feb. 1999) (TESLA-1017)
- Walker, Jearl, “Fundamentals of Physics,” 10th Edition, Halliday & Resnick, ISBN 978-1-118-23072-5 (“Walker”) (TESLA-1018)
- U.S. Pat. App. No. 2004/0180670 (“Pande”) (TESLA-1019)
- U.S. Pat. No. 7,860,647 (“Amano”) (TESLA-1020)
- U.S. Pat. No. 7,460,946 (“Shima”) (TESLA-1021)
- U.S. Pat. No. 6,675,085 (“Straub”) (TESLA-1022)

21. I have also reviewed various supporting references and other documentation as further noted in my opinions below.

22. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '399 patent at the time of the earliest possible priority date of the '399 patent, and I have done so during my review of these materials. The '399 patent claims the benefit of priority to a series of applications dating to an earliest date of November 17, 2005 (“the Critical Date”). Counsel has informed me that the Critical Date represents the earliest possible priority date to which the challenged claims of '399 patent are entitled, and I have therefore used that Critical Date in my analysis below.

23. I have no financial interest in the parties or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

24. In writing this declaration, I have considered the following: my own knowledge and experience, including my work experience in the field of transportation systems; my experience in teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed various publications and materials, in addition to other materials I cite in my declaration.

25. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the '399 patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the art as of the Critical Date, or before. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the '399 patent and the prior art discussed below.

II. OVERVIEW OF CONCLUSIONS FORMED

26. This declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions, based upon my knowledge and experience and my review of the prior art publications listed above, I believe that:

- Claims 1, 2, 5, 6, 9-12, 15, 16, 19, and 20 of the '399 patent are made obvious over Hongo, Obradovich, and Niki.
- Claims 3, 4, 13 and 14 of the '399 patent are made obvious by Hongo, Obradovich, Niki, and Kudo.
- Claims 7 and 17 of the '399 patent are made obvious by Hongo, Obradovich, Niki, and Kuroda.
- Claims 8 and 18 of the '399 patent are made obvious by Hongo, Obradovich, Niki, and Newstrom.

III. LEVEL OF ORDINARY SKILL IN THE ART

27. In my opinion, one of ordinary skill in the art relating to, and at the time of, the invention of the '399 patent would have had a bachelor's degree in electrical engineering, computer engineering, mechanical engineering, civil engineering (transportation systems), physics, or a related field, and at least four years of experience (or the academic equivalent) in the field of transportation systems.

28. Based on my experiences, I have a good understanding of the capabilities of one of ordinary skill. Indeed, I have taught, participated in organizations, and worked closely with many such persons over the course of my career. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of one of ordinary skill. Furthermore, I possess those capabilities myself.

IV. OVERVIEW OF THE '399 PATENT

A. Specification

29. The '399 patent identifies its field of invention as “devices, methods and systems for controlling power applied to a vehicle engine.” TESLA-1001, 1:16-17. While the Background of the '399 patent generally discusses fuel efficiency (*see id.*, 1:22-2:17), the '399 patent that make clear that its purported invention is not limited to improving fuel efficiency. *See id.*, 6:46-49 (“The power

supplied to the engine may **alternatively** be optimized based on other criterion.

For example, the power supplied to the engine may be optimized with respect to **speed** or travel time.”).

30. The power optimization techniques described in the '399 patent are not limited to fuel efficiency, and encompasses, for example, power optimization based on vehicle speed. *See id.*, 3:2-4 (disclosing that a fuel efficient speed is merely an example of “an optimal speed”); 6:58-60 (disclosing a broad view of “fuel” as “refer[ring] to any appropriate power source for the engine.”). Power optimization techniques that account for diverse external conditions (e.g., weather, road surface temperature) and other information in adapting vehicle operation are within the scope of the '399 patent claims.

B. Claims

31. The table below includes identifiers for the '399 patent claims and limitations, which are referenced throughout.

Claim 1	
[1.pre]	A method of electric vehicle operation, comprising:
[1.a]	determining a segment of a vehicle route;
[1.b.1]	determining information about an external environment of a vehicle,
[1.b.2]	information about operational status of the vehicle,
[1.b.3]	information from external command input telemetry

[1.b.4]	in combination with user command inputs to the vehicle including voice command inputs; and
[1.c]	applying calculated electric power to the vehicle to travel along the segment of the vehicle route at a calculated speed.
Claim 2	
[2]	The method of claim 1, wherein electric power can be derived from operation of an internal combustion engine.
Claim 3	
[3]	The method of claim 1, further comprising the step of selecting a destination using historical data associated with a driver.
Claim 4	
[4]	The method of claim 1, further comprising the step of selecting a destination using statistical destination logic.
Claim 5	
[5]	The method of claim 1, further comprising the step of selecting a destination by at least one of a driver and a passenger.
Claim 6	
[6.1]	The method of claim 1, wherein vehicle route segment determination further comprises determining multiple route segments,
[6.2]	each route segment having a separate calculated speed and selected drive train parameters.
Claim 7	

[7]	The method of claim 1, wherein the step of determining information about an external environment of a vehicle further comprises the step of communicating with a remote database.
Claim 8	
[8]	The method of claim 1, wherein the step of determining information about operational status of a vehicle further comprises the step of communicating with a remote database.
Claim 9	
[9]	The method of claim 1, wherein voice command inputs are provided to the vehicle by a separate source.
Claim 10	
[10]	The method of claim 1, wherein voice command inputs are provided to the vehicle by a device having GPS functionality.
Claim 11	
[11.pre]	An electric vehicle, comprising:
[11.a.1]	a vehicle having an electric power source,
[11.a.2]	a communication system, and
[11.a.3]	a user interface system capable of accepting vehicle command inputs; and
[11.b.1]	a power management system for the electric power source able to
[11.b.2]	determine information about an external environment of a vehicle,
[11.b.3]	information about operational status of the vehicle,
[11.b.4]	information from external command input telemetry
[11.b.5]	combinable with user command inputs to the vehicle including voice command inputs provided by the user interface system,
[11.b.6]	and one or more operational parameters of the vehicle,

[11.c.1]	with the power management system set to calculated electric power and speed over a segment of a vehicle route and
[11.c.2]	act to apply calculated electric power to the vehicle to travel along the segment of the vehicle route at the calculated speed.
Claim 12	
[12]	The apparatus of claim 11, wherein electric power from the electric power source can be derived from operation of an internal combustion engine.
Claim 13	
[13]	The apparatus of claim 11, wherein vehicle route is set based on a destination determined at least in part using historical data associated with a driver.
Claim 14	
[14]	The apparatus of claim 11, wherein vehicle route is set based on a destination determined at least in part using statistical destination logic.
Claim 15	
[15]	The apparatus of claim 11, wherein vehicle route is set based on a destination determined by at least one of a driver and a passenger via the user interface system.
Claim 16	
[16]	The apparatus of claim 11, wherein vehicle route segment determination is based at least in part on determining multiple route segments, each route segment having a separate calculated speed.
Claim 17	

[17]	The apparatus of claim 11, wherein determining information about an external environment of a vehicle further comprises communicating with a remote database.
Claim 18	
[18]	The apparatus of claim 11, wherein determining information about operational status of a vehicle further comprises communicating with a remote database.
Claim 19	
[19]	The apparatus of claim 11, wherein calculated speed is based at least in part on a determined probable optimal speed using historical route information.
Claim 20	
[20]	The apparatus of claim 11, wherein target speed is presented as a range of target speeds.

C. Prosecution History

32. The '399 patent issued with without any Office Action. *See generally* TESLA-1002. There is no indication from the Prosecution History that the prior art references discussed in Section V was considered and/or substantively applied by the Examiner. *Id.* None of the references were cited in original examination or considered by the Examiner. The Notice of Allowance also did not include any Examiner's Statement of Reasons for Allowance. *Id.*, 26-27. The Examiner seems overlooked prior art disclosures of adaptive cruise control (e.g., in Hongo). As

discussed in Section VI.A-D, Hongo, in combination with Obradovich, Niki, Kudo, Kuroda, and Newstrom make the Challenged Claims obvious.

V. SUMMARY OF RELEVANT PRIOR ART

A. Hongo¹

33. Hongo is based on a Japanese patent publication² focused on techniques for using vehicle speed monitoring and management to provide adaptive cruise control. This is accomplished using an “on-vehicle target vehicle speed determining device,” which “determines a target speed of a moving vehicle based on its current location.” TESLA-1005, [0001]. This device “automatically controls the speed of a vehicle” and thereby enables an “adaptive cruise control system.” *Id.* Hongo observes that cruise control systems are “widely known” as of its filing, but notes that these systems do not consider external road conditions,

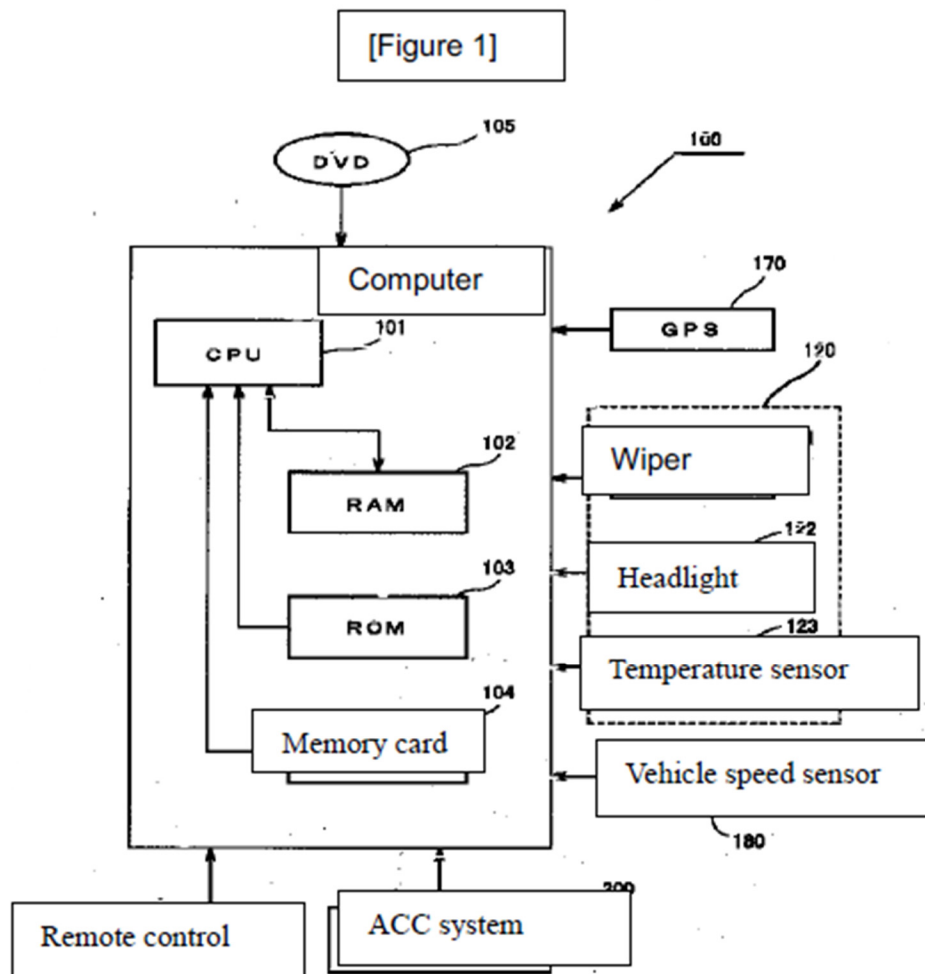
¹ Descriptions of the references and combinations thereof are incorporated into each mapping that includes citations to these references. All emphasis is added unless otherwise indicated.

² This declaration cites to TESLA-1005, which is a certified translation of JP 2003-276472 (TESLA-1007). *See* TESLA-1006 (translation certification). The disclosure in TESLA-1007 is incorporated by reference via citations to TESLA-1005.

such as “weather and sunlight conditions” and regulating vehicle speed. TESLA-1005, [0002]; *see id.*, [0003]-[0005].

34. Hongo identifies two problems created by the limitations of prior art cruise control systems. First, “[i]f a constant vehicle speed that is sufficiently safe for all situations is always adopted as the target vehicle speed, on a dry road with a good view during the daytime and clear weather, the target vehicle speed tends to be relatively slow compared to the desired value.” TESLA-1005, [0006]. Second, “it is desirable to change the target vehicle speed from time to time in response to weather (sunny/rainy/snow, etc.) and sunshine conditions that can change naturally over time.” *Id.*

35. To address these limitations, Hongo proposes systems and techniques that “automatically output[] an optimized or optimized target vehicle speed according to weather, sunlight conditions, etc., which can change naturally and over time...” TESLA-1005, [0007]. The architecture of Hongo’s system is generally shown in FIG. 1 below:



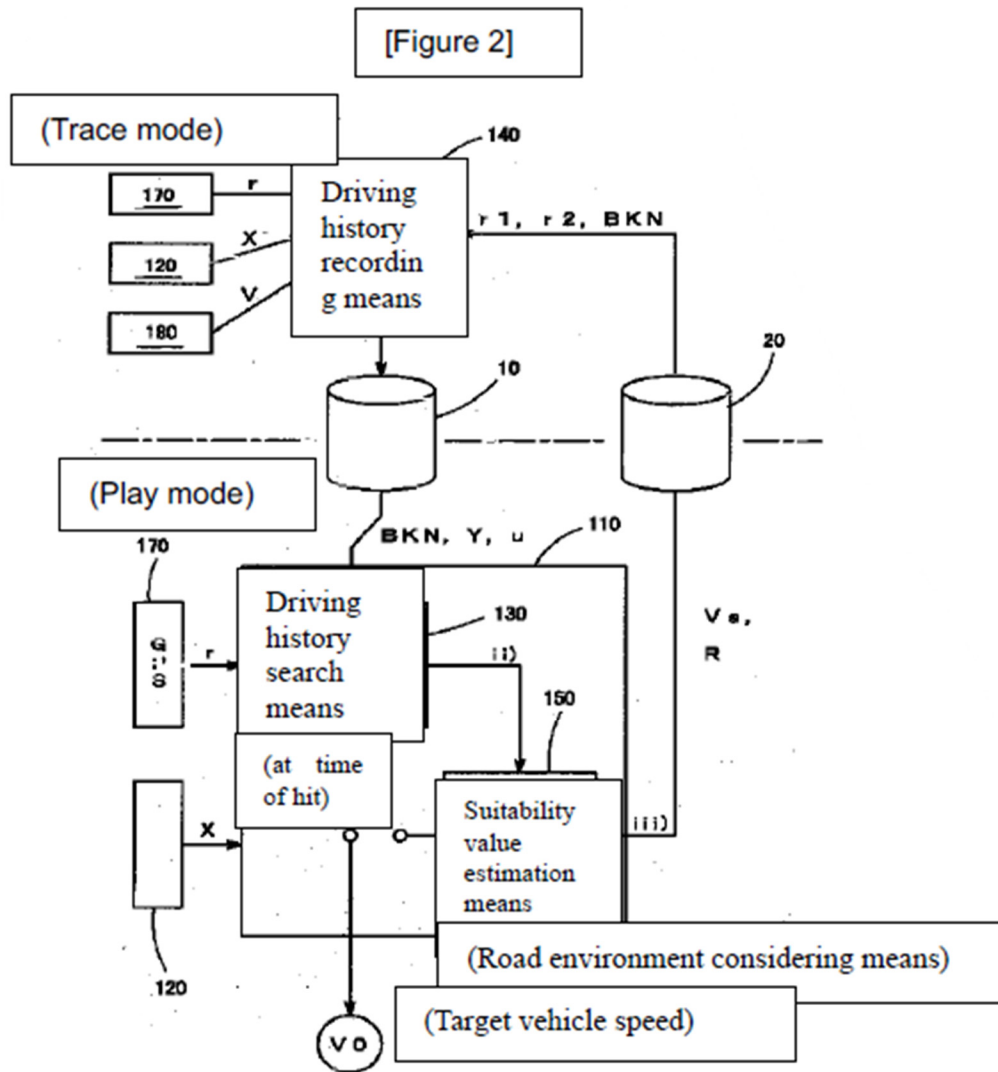
TESLA-1005, FIG. 1

36. As shown above, the system includes a “target speed determining device 100” (“device 100”), which further includes computing elements, such as CPU 101, RAM 102, ROM 103, and memory card 104. TESLA-1005, [0022]. The system also includes DVD 105, which “stores data such as map information and legal speed limits, as well as programs.” *Id.*

37. GPS device 170 “provides current vehicle position information sent from satellites.” *Id.*, [0023]. Environmental information acquisition means 120 includes various sensing elements to capture external environmental information associated with a vehicle. *Id.* As examples, wiper 121 collects a “wiper activation signal” and temperature sensor 123 collects a “road surface temperature.” *Id.* Additionally, vehicle speed sensor 180 collects a “vehicle speed signal.” *Id.*

38. Device 100 is connected to an automatic cruise control (ACC) system 200, and device 100 “outputs [a] target vehicle speed V0 to the ACC system 200.” TESLA-1005, [0024]. As noted above, Hongo states that cruise control systems, such as ACC system 200, were conventional by its filing date. *See id.*, [0002] (citing U.S. Pat. No. 6,161,072 and J.P. Pat. No. 8-290728 as examples of cruise control systems). By disclosing the calculation and output of a “target vehicle speed” to a cruise control system of the vehicle, Hongo teaches calculating and applying power, where “[t]he applied power ... [is] expressed as an optimized speed or speed to which the vehicle is controlled.” TESLA-1001, 2:53-55.

39. FIG. 2 shows a “data flow” relating to the operation of device 100:

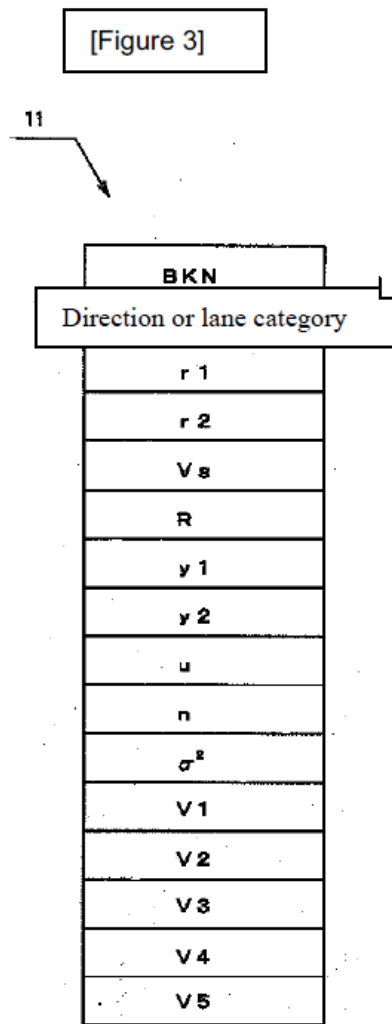


TESLA-1005, FIG. 2

40. As shown above, the Hongo system further includes a “driving history recording means 140” (“means 140”) and a “road environment considering means 110” (“means 110”), “each [of which is] realized by software running on [a] computer.” TESLA-1005, [0026]. Means 110 includes “driving history search means 130, and preferred value estimating means 150.” *Id.*

41. Means 140 generally serves two functions in the data flow shown in Figure 2. First, in a “trace mode,” means 140 generates data for storage in “driving block DB 20” (“DB 20”). TESLA-1005, [0027]. This is accomplished by “acquir[ing] position information (current position coordinates r) from the GPS 170” and “dividing it into sections approximately every 20m in the driving direction on the road being driven...” *Id.* The information is stored in driving block DB 20, which “specif[ies] the block number BKN of [a] driving block,” along with associated information, such as “block range coordinates ($r1$, $r2$) of each driving block,” “legal speed limit Vs of the driving block,” and “the minimum radius of curvature R .” *Id.*

42. FIG. 3 is a table illustrating the “record format of the driving history data 11 recorded in the driving history DB 10.” TESLA-1005, [0029].



TESLA-1005, FIG. 3

43. As shown above, the block number BKN of a driving block is stored with associated information, such as “‘Direction or Lane Classification’,” which is for “classifying the current direction of travel (up/down, etc.) on the road being driven on.” TESLA-1005, [0029]. Other information associated with a “driver block” includes “block range coordinates (r1, r2),” “legal speed limit Vs,” “minimum radius of curvature R,” and “weather code y1 and sunshine code y2.”

Id., [0027], [0030]. Additionally, “the natural number n ” represents “the number of valid vehicle speed data,” e.g., v_1, v_2, v_3, v_4, v_5 . *Id.*, [0031]. Additionally, “ u is the average value of valid vehicle speed data,” which, in some instances, “can be used as is, as the target vehicle speed V_0 in the later reproduction mode.” *Id.* Finally, “ σ^2 is the variance of n pieces of vehicle speed data, and can be used when performing various well-known statistical operations such as evaluating the reliability of vehicle speed data.” *Id.*

44. Means 140 processes “road environment real-time information X ” (e.g., “wiper operation signal, headlight operation signal, road surface temperature”), which is “obtained from the environment information acquisition means 120.” TESLA-1005, [0028]. Additionally, the “current vehicle speed V ” is obtained from the “vehicle speed sensor 180.” *Id.* The “road environment real time information X ” is used to derive a “road environment parameter Y ” to identify external weather conditions (e.g., “weather code y_1 ,” “sunshine code y_2 ”). *Id.*, [0030].

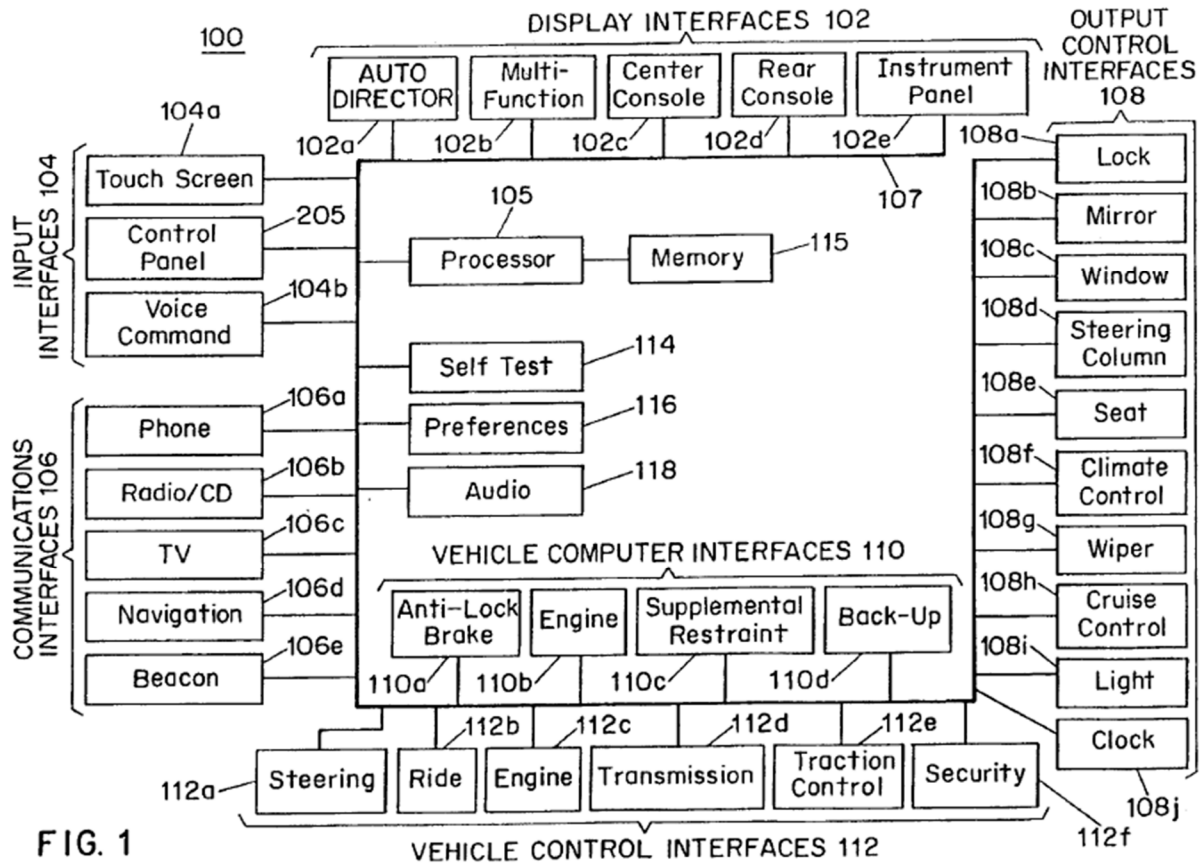
45. As shown in Figure 2, in the “playback mode” (also referred to as the “reproduction mode”), means 110 then processes information derived by means 140 (e.g., road environment parameter Y , block number BKN) to calculate the “target vehicle speed V_0 .” TESLA-1005, [0032]. Calculations for target speed are discussed in greater detail below with respect to [1.c].

46. Hongo is analogous art to the '399 patent. Hongo is from the same field of endeavor (e.g., vehicle speed control) and is reasonably pertinent to a problem the '399 patent was trying to solve (e.g., inefficiencies associated with the speed or travel time of a vehicle). *See* TESLA-1001, 1:22-2:17; *see also id.*, 3:2-4, 6:58-50, 19:65-20:2.

B. Obradovich

47. Obradovich is a U.S. patent focused on a “multimedia information and control system for use in an automobile.” TESLA-1008, Abstract. Obradovich’s broad motivation is to “design an information and control system for use inside an automobile with the user in mind.” *Id.*, 3:21-31. Such control may be accomplished through “voice command[s]” to “select or control various options or functions provided by [the system]...” *Id.*, 7:17-21. For example, a “voice command interface 104b” with “standard voice command circuitry” is used for “processing voice commands by the user through [a] microphone to control or modify selected functions” of the system. *Id.*, 6:56-62.

48. Figure 1 shows a block diagram of an automobile information and control system 100 (“system 100”):



TESLA-1008, FIG. 1

49. System 100 is referred to as an “AUTO DIRECTOR’ system” that is “user-friendly and designed with the automobile user in mind.” TESLA-1008, 4:66-5:15. System 100 includes several types of componentry, including processor 105, memory 115, data bus 107, display interfaces 102, input interfaces 105, communications interfaces 106, output control interfaces 108, vehicle computer interfaces 110, vehicle control interfaces 112, self-test interface 114, preferences interface 116, and audio interface 118. *Id.*, 5:16-22.

50. In describing operation of its “AUTO DIRECTOR interface,” Obradovich states “[w]ith such touch-screen and displayed option selection capabilities, through AUTO DIRECTOR interface 102a, the user is able to obtain information and control selectable functions of the automobile such as the instrument panel, navigation function, mobile phone, radio/CD player, locks, mirrors, windows, driver’s seat adjustment control, climate control, windshield wipers, **cruise control**, lights, security function, steering, ride control, engine and transmission.” *Id.*, 5:45-52.

51. As to cruise control, system 100 includes a “[c]ruise control interface 108h” including “output control logic controllable by processor 105 to (1) turn the cruise control on or off, (2) set the vehicle speed, and (3) cancel or resume the set speed.” TESLA-1008, 8:15-19. Additionally, “wherever the touch screen capability may be used to select or control various options or functions provided by system 100, the voice command is equally applicable.” *Id.*, 7:17-21. Given these disclosures, Obradovich teaches that a user can use voice commands (e.g., via the voice command interface 104b) to adjust output control logic relating to cruise control functionality (e.g., via cruise control interface 118).

52. Obradovich is analogous art to the ’399 patent. Obradovich is from the same field of endeavor (e.g., vehicle management and control) and is

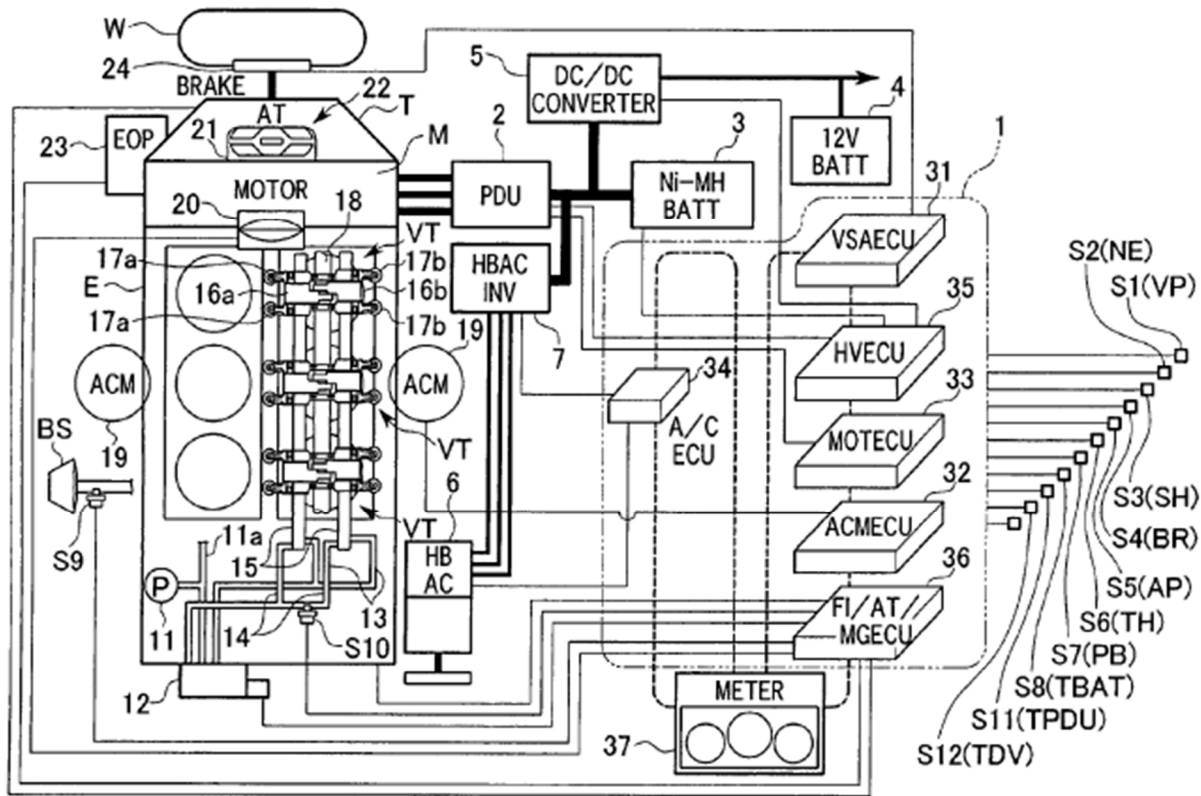
reasonably pertinent to the problem the '399 patent was trying to solve (e.g., overly complicated user interfaces of vehicle operation). *See* TESLA-1001, 22:60-23:22.

C. Niki

53. Niki discloses a control apparatus for a hybrid vehicle that is “driven by jointly using an internal-combustion engine and a motor...” TESLA-1009, 1:13-17. Niki’s hybrid vehicle is an example of “any appropriate vehicle” described in '399 patent as incorporating the disclosed “devices and systems.” TESLA-1001, 4:64-5:3 (“a hybrid internal combustion/electric vehicles”); *see also id.*, 6:39-60 (“the devices, methods and systems described herein may be used with vehicles having a hybrid internal combustion/electric engine...”), 25:18-32 (describing a “Fuel Efficient Hybrid Vehicle”).

54. Figure 1 shows an example of Niki’s “parallel hybrid vehicle”:

Fig. 1

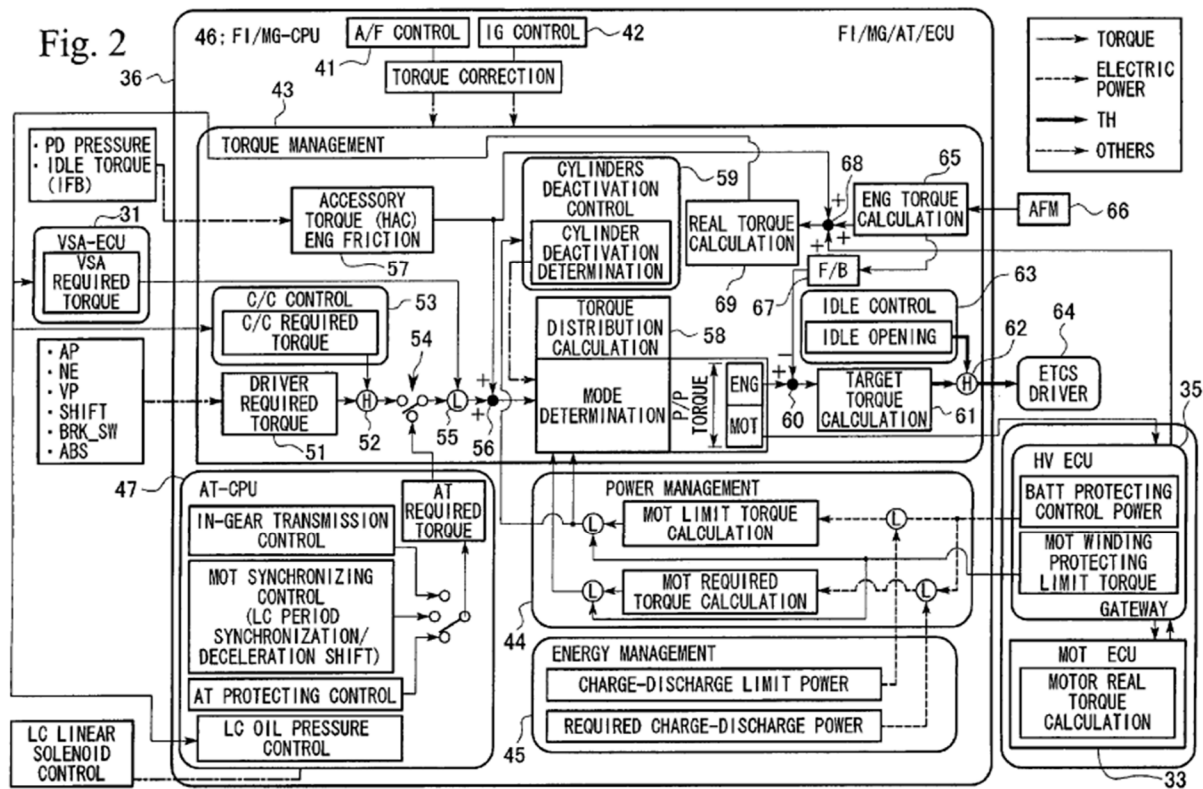


TESLA-1009, FIG. 1

55. The hybrid vehicle includes an “internal-combustion engine E, a motor M, and a transmission T [] connected directly in series.” TESLA-1009, 5:17-32. The hybrid vehicle also includes “auxiliary battery 4 of 12 volts” for “driving various accessories,” along with a “battery 3 in parallel via a downverter 5[,] which is a DC-DC converter.” *Id.*, 5:55-60. The downverter 5 is “controlled by the control unit 1 and charges the auxiliary battery 4 by lowering the voltage of the power drive unit 2 or the battery 3.” *Id.* The power drive unit 2 operates “under the control of the control unit 1” and “converts the DC power output from the

power drive unit 2 and the battery 3 into three-phase AC power to supply to the air conditioning motor so as to drive control the hybrid air conditioning compressor 6.” *Id.*, 5:61-6:5.

56. Figure 2 shows an example of the control unit 1 shown in FIG. 1:



TESLA-1009, Fig. 1

57. Control unit 1 includes a “CC (cruise control) unit 53,” which “calculates the torque value (C/C required torque)” using “traveling conditions previously set according to the input operation of the driver...” TESLA-1009, 8:47-59. Niki describes “cruise control” as referring to “constant speed travelling control,” which involves “control[ing] the internal-combustion engine E and the

motor M so that the vehicle travelling speed VP detected in a vehicle speed sensor S1 becomes the target vehicle speed...” *Id.* The “target vehicle speed” is “the target value of the traveling speed of the vehicle.” *Id.*

58. Niki is analogous art to the ’399 patent. Niki is from the same field of endeavor (e.g., electric and hybrid vehicles) and is reasonably pertinent to the problem the ’399 patent was trying to solve (e.g., challenges associated with controlling the power supplied to electric or hybrid vehicles). *See* TESLA-1001, 2:13-17, 4:64-5:3, 6:39-60, 25:18-32.

D. Kudo

59. Kudo discloses “a technology for predicting a travel destination” of a vehicle. TESLA-1010, [0001]. The prediction generally involves “accumulating, as a travel history, a travel route obtained from the history of position information of the mobile body,” e.g., the vehicle. *Id.*, [0013]. This travel history is used to “predict[] one or more travel destinations where the mobile body will advance,” considering factors such as “time, date, weather, driver, a fellow passenger, and the like.” *Id.*, [0013], [0014]. Kudo’s travel destination prediction thereby is an example of the destination selection techniques described in the ’399 patent. TESLA-1001, 20:54-67 (describing “statistical destination logic” for “infer[ing] one or more likely destinations based on [] information inputs,” e.g., “current location and direction of the vehicle, and the date and time of day”).

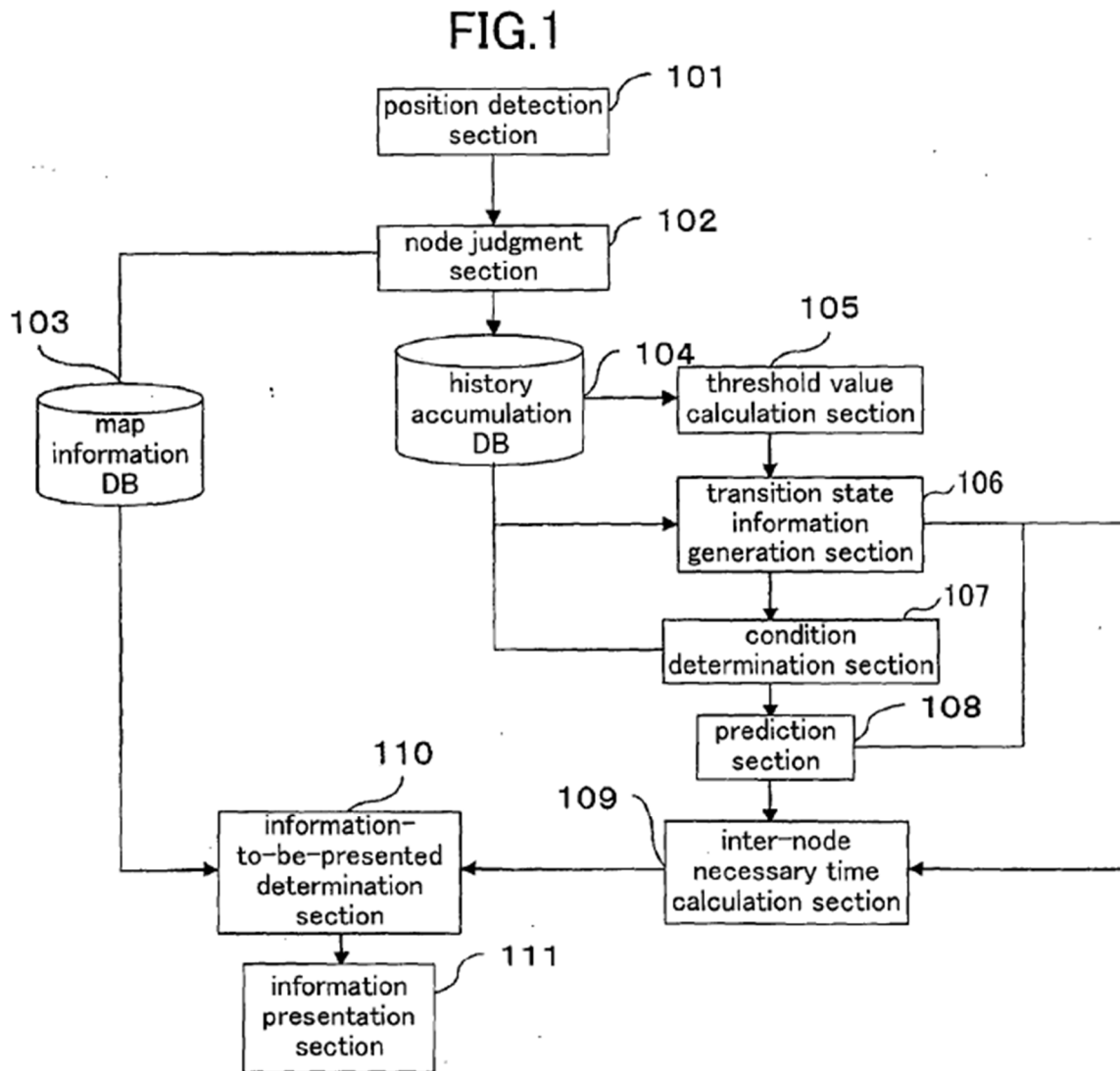
60. Kudo's prediction technology is based on the concept of "nodes," which can represent "intersections, landmarks, area names, and the like." TESLA-1010, [0081]. An example of node relating information stored in a map information database" is illustrated in Figure 2:

FIG.2

node number	kind/name	east longitude	north latitude
C1	intersection	135' 20"35.45"	34' 44"35.22"
C2	intersection	135' 24"35.74"	34' 44"86.5"
C3	intersection	135' 22"6.22"	34' 44"78.18"
C4	intersection	135' 22"10.4"	34' 45"60.75"
C5	intersection	135' 22"20.0"	34' 46"79.37"
C6	intersection	135' 20"42.76"	34' 46"70.48"
C7	intersection	135' 22"35.39"	34' 47"35.82"
.	.	.	.
L123	landmark (home)	135' 19"48.42"	34' 42"38.29"
L124	landmark (office)	135' 30"22.33"	35' 12"23.6"
.	.	.	.
A427	area (Umeda, North)	135' 29"51.9"	34' 41"57.0"
A428	area (Keihanna, Gakuentoshi)	135' 46"18.80"	34' 44"30.65"

TESLA-1010, FIG. 2

61. Figure 1 shows an example of Kudo's information acquisition system for predicting a destination of a vehicle:



TESLA-1010, FIG. 1

62. A position detection section 101 “detects information on the current position of the car navigation system (the current position of an automobile as a mobile body on which the car navigation system is boarded.” TESLA-1008,

[0077]. A node judgment section 102 “judges whether or not the current position detected by the position detection section 101 corresponds to a node...” *Id.* A map information database 103 “stores map information to be used for car navigation.” *Id.*

63. A history accumulation database (DB) 104 “accumulates a travel route obtained from a history of the position information of the automobile as a travel history.” *Id.*, [0078]. A threshold value calculation section 105 “calculates a threshold value for a node appearance frequency which is used for generating transition state information.” *Id.* A transition state information generation section 106 “generates transition state information indicating past position transition of the automobile from the travel history accumulated in the history accumulation DB 104 and condition determination section 107.” *Id.* The condition determination section 107 “determines a condition for retrieval for obtaining an appropriate prediction result from information indicating the current state accumulated in the history accumulation DB 104 by utilizing the transition state information.” *Id.*, [0079]. Finally, a prediction section 108 “performs prediction of a future travel destination from the transition state information, using the condition for retrieval determined by the condition determination section 107.” *Id.*

64. An example of travel history data “accumulated in the history accumulation DB” is shown in FIG. 3. TESLA-1010, [0087]. Notably, the history

accumulation database stores both “information relating to the current travel” and “the past history information.” *Id.*, [0096]. The history accumulation database stores “pairs of the node numbers and times of passage therethrough” for the nodes passed by the vehicle during “segment unit[s],” where each row of the tables in FIG. 3 corresponds to one such node. *Id.*

FIG.3

104

node number	time
L6	8:05 a.m. on July 31
C8	8:06 a.m. on July 31
C12	8:08 a.m. on July 31
C9	8:09 a.m. on July 31
C34	8:11 a.m. on July 31
.	.
.	.
L128	8:53 a.m. on July 31

(a)

node number	time
L128	12:25 p.m. on July 31
C140	12:29 p.m. on July 31
C125	12:36 p.m. on July 31
.	.
.	.
L68	1:33 p.m. on July 31

(b)

node number	time
L6	8:05 a.m. on July 31
C8	8:06 a.m. on July 31
C20	8:08 a.m. on July 31
L12	8:10 a.m. on July 31
L12	1:40 p.m. on July 31
C34	1:50 p.m. on July 31
.	.
.	.
L6	9:20 p.m. on July 31

TESLA-1010, FIG. 3

65. Kudo is analogous art to the '399 patent. Kudo is from the same field of endeavor (e.g., vehicle navigation) and is reasonably pertinent to the problem the '399 patent was trying to solve (e.g., challenges associated with destination prediction while a vehicle is traveling along a route). TESLA-1001, 1:22-2:17, 20:54-67.

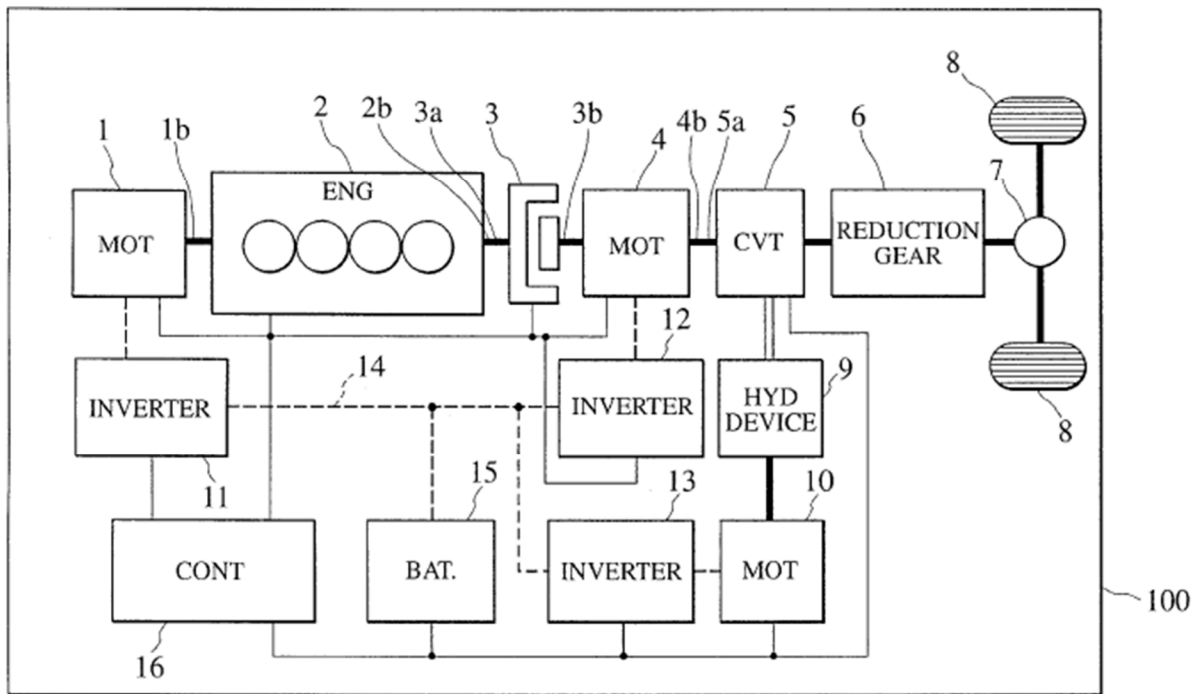
E. Kuroda

66. Kuroda discloses a “driving control apparatus of a hybrid vehicle” that can “set an operating schedule of an engine and a motor so as to minimize fuel consumption in accordance with road conditions of a route to a destination.”

TESLA-1011, 1:6-11. Kuroda’s vehicle includes a vehicle information communication system (VICS) for “receiv[ing] traffic information and road information by a beacon receiver, and a road map database.” TESLA-1011, 4:56-67. Reception of information from a road map database in Kuroda’s vehicle is an example of techniques described in the ’399 patent of communicating with a remote database. TESLA-1001, 8:17-32 (describing embodiments where “the power management device communicates with one or more such databases to identify the location and surrounding road features,” including “traffic patterns”).

67. Figure 1 shows an example of a driving control apparatus for a hybrid vehicle 100:

FIG. 1



TESLA-1011, FIG. 1

Hybrid vehicle 100 includes a “navigation system 34” for “detecting the present location of the vehicle...” TESLA-1011, 4:56-67. Navigation system 34 can also detect a “driving route” using a “vehicle roadside communication device (such as [Vehicle Information Communication System (VICS)] or FM multiplexing broadcast) for receiving traffic information and road information by a beacon receiver, and a road map database.” *Id.* Further, navigation system 34 “retrieves a route to a destination and detects the road conditions on the retrieved route.” *Id.*

68. Kuroda is analogous art to the '399 patent. Kuroda is from the same field of endeavor (e.g., vehicular communications with remote databases) and is

reasonably pertinent to the problem the '399 patent was trying to solve (e.g., challenges associated with vehicle operation and control using information obtained from a remote database). *See* TESLA-1001, 8:17-32.

F. Newstrom

69. Newstrom discloses a geographic information system (GIS) that populates a “geospatial database” that stores “geospatial data relating to a travel path for [a] host vehicle.” TESLA-1012, Abstract. Newstrom’s “geospatial database” is an example of remote databases that the '399 patent describes is in communication with a power management system. TESLA-1001, 8:17-32 (describing embodiments where “the power management device communicates with one or more such databases to identify the location and surrounding road features”).

70. Figure 1 shows an example of a geospatial database management system 10 to be used on a host vehicle 12 with one or more onboard intelligent subsystems 14:

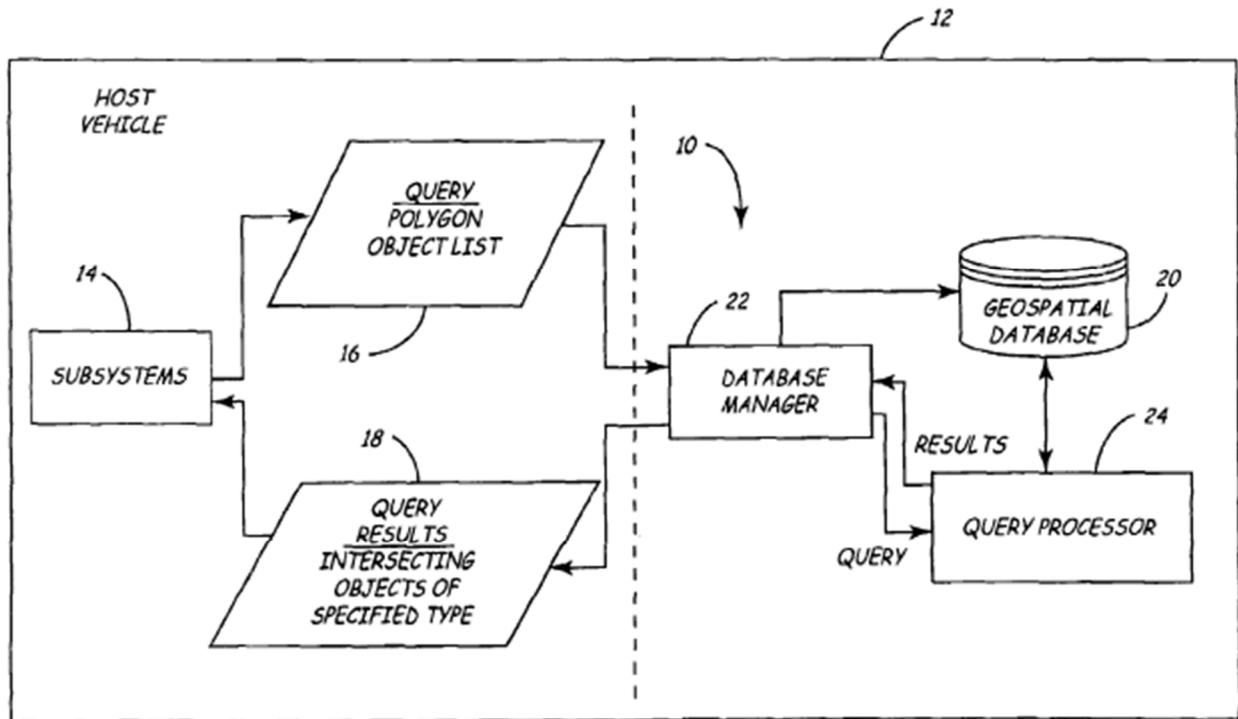


FIG. 1

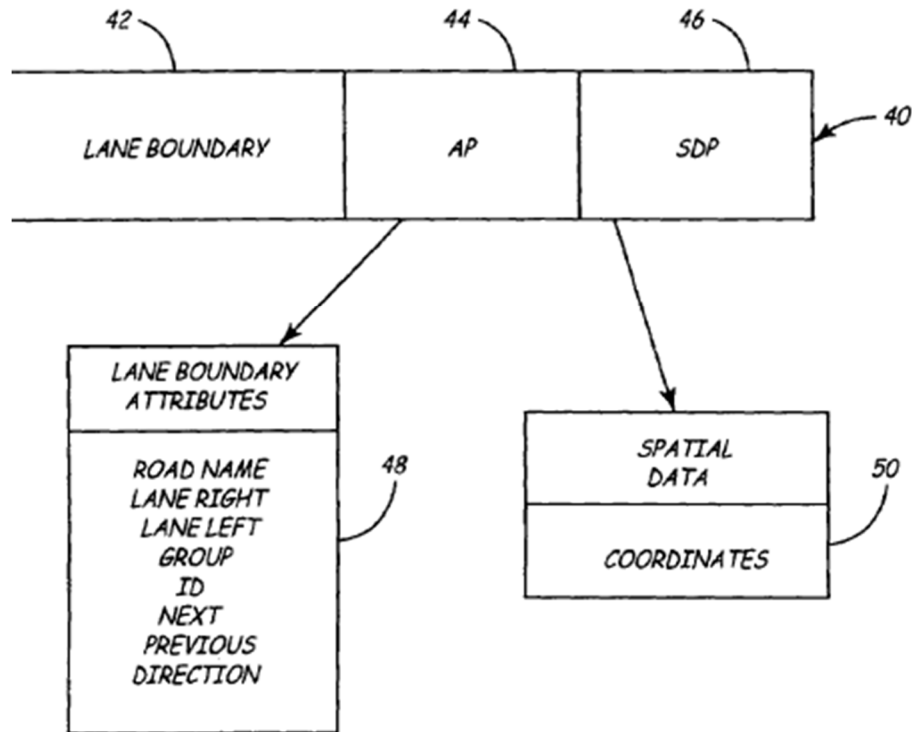
TESLA-1012, FIG. 1

Subsystems 14 “provide an operator interface which conveys information to the operator indicative of the position of vehicle 12 within a lane of traffic, and also indicate[s] to the driver information about objects around the vehicle.” TESLA-1012, 3:47-58. Road information used by subsystems 14 is stored in geospatial database 20, and retrieved through database manager 22 by query processor 24. *Id.*, 4:12-16.

71. One example of road information described in Newstrom is lane boundary information, which can be used by a “lane keeping assist subsystem” for use in “convey[ing] information to [an] operator indicative of the position of

vehicle 12 within a lane of traffic...” *Id.*, 3:47-58. Figure 3 illustrates the organization of lane boundary information in geospatial database 20.

FIG. 3



TESLA-1012, FIG. 3

72. As shown above, database 20 includes an entry 40 representing a “LaneBoundary object,” and includes “object type identifier section 42 that identifies the object type, along with a pair of pointer sections 44 and 46.” TESLA-1012, 6:23-40. Pointer 44 “points to a location within geospatial database 20 that contains the attributes 48 associated with the LaneBoundary object identified by 42.” *Id.* Pointer 46 “points to a location within geospatial database 20

that contains the spatial data 50 corresponding to the LaneBoundary object identified by identifier 42.” *Id.* The spatial data 50 includes, for example, “X, Y, and Z coordinates or longitude, latitude and elevation coordinates, or any other coordinates that identify the location of the particular object” represented by identifier 42. *Id.*

73. Newstrom describes using the lane boundary information in geospatial database 20 to generate “[w]arnings of lane departure” through “use of steering wheel vibrations or oscillations...” TESLA-1012, 7:56-64. Lane departures may be determined using, for example, “the Time to Lane Crossing (TLC) approach,” which is based on “the vehicle’s speed, orientation relative to [a] LaneCenter” or other attributes. *Id.*

74. Newstrom also describes feedback systems to provide a vehicle operator with driving assistance. For example, a “virtual rumble strip” may “generate[] haptic feedback that provides a ‘feel’ of the road to the driver by imposing, for example, a reactive torque as a function of positional change relative to the road geometry.” TESLA-1012, 4:54-5:6. Additionally, “as the operator drifts further from the center line [of a lane], the virtual rumble strip may increase oscillation giving the operator a sense of which direction to steer back to the center of the lane.” *Id.*

75. Newstrom is analogous art to the '399 patent. Newstrom is from the same field of endeavor (e.g., vehicular communications with remote databases) and is reasonably pertinent to the problem the '399 patent was trying to solve (e.g., challenges associated with vehicle operation and control using information obtained from a remote database). *See* TESLA-1001, 8:17-32.

VI. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. [GROUND 1] – HONGO, OBRADOVICH, AND NIKI MAKES CLAIMS 1, 2, 5, 6, 9-12, 15, 16, 19, AND 20 OBVIOUS

1. Combination of Hongo and Obradovich

76. Hongo generally describes systems and techniques relating to adaptive cruise control, where a target speed of a vehicle is adjusted based on external road conditions. When combined with Obradovich, which describes a specific implementation of an information and control system of a vehicle, a vehicle incorporating the teachings of Hongo and Obradovich makes the reception of voice command inputs to a vehicle obvious.

77. A POSITA looking to implement Hongo's adaptive cruise control techniques would have recognized that Hongo lacks disclosure of vehicle components required to implement user control of cruise control functionality. For example, Hongo contemplates existence of an ACC system 200 that provides cruise control, but lacks specific descriptions relating to user interactions with cruise control functionality. *See* TESLA-1005, [0003], [0004], [0024]. A POSITA

would have therefore looked beyond Hongo to well-known configurations of cruise control systems in the vehicle.

78. A POSITA would have discovered Obradovich, which is similarly user-focused but provides disclosure of the input and output interfaces for controlling various vehicle functions, including cruise control functionality. In reviewing Obradovich's disclosure, a POSITA would have recognized that Obradovich's system 100 (which is used to provide a standardized vehicle control through use of touch and voice interfaces) exists in a vehicle independently of Hongo's device 100 (which is used to calculate a target vehicle speed for adaptive cruise control based on external conditions). In combining Hongo and Obradovich, a POSITA would have incorporated the teachings of each of Hongo's device 100 and Obradovich's system 100 into a vehicle to provide the advantages of each. Such a combination would have provided new types of advantages that further ease vehicle operation, such as enabling the user to use voice commands to adjust cruise control.

79. Specifically, a POSITA would have recognized that Obradovich's "voice command interface 104b" enables a type of vehicle control that improves Hongo's contemplated use of adaptive cruise control. Obradovich recognizes that drivers may become "distracted or overburdened by irrelevant information in the course of an information retrieval..." TESLA-1008, 3:32-49. To address this

challenge and enable a “safe driving environment,” Obradovich focuses its techniques to enable information access that is “intuitive and direct.” *Id.* A POSITA would have thereby recognized from this disclosure that Obradovich’s use of voice commands improves vehicle operation in Hongo by allowing a user to use voice to adjust adaptive cruise control. Obradovich motivates this configuration through teachings or suggestions that preventing a user from being “distracted or overburdened by irrelevant information in the course of an information retrieval” is “[a]dvantageous[]” since it is “conducive to a safe driving environment.” *Id.*

80. The combination of Hongo and Obradovich would have also provided improvements to user interfaces of a vehicle by providing greater convenience and flexibility in input choices. Hongo recognizes “it is not always possible to ensure sufficient convenience” when using prior art adaptive cruise control systems. TESLA-1005, [0006]. Obradovich provides a possible solution to this problem through “touch-screen and displayed option capabilities,” which enable a user to “obtain information on and control selectable functions of the automobile,” including “cruise control.” TESLA-1008, 5:33-53. A POSITA would have perceived the benefit of implementing a vehicle that incorporates Obradovich’s touch screen and selection capabilities to allow a user to have improved control over the adaptive cruise control functionality described in Hongo.

81. A POSITA would have been motivated to combine the teachings of Hongo and Obradovich as discussed above since the combination involves incorporating prior art elements according to known methods in a vehicle to yield predictable results. As discussed above, Hongo's system 100 and Obradovich's system 100 were each well-known by the Critical Date, and their incorporation in a vehicle would have predictably improved user convenience while interacting with adaptive cruise control functionality of the vehicle. TESLA-1005, [0006]; TESLA-1006, 3:21-31. Further, the proposed combination would have involved use of known techniques of improving user convenience during vehicle operation to improve similar vehicles with cruise control functionality in the same way. *See* TESLA-1005, [0006]-[0007] (describing techniques that "ensure sufficient convenience" when using adaptive cruise control); TESLA-1008, 5:33-53 (describing techniques that enable a user to "obtain information on and control selectable functions of the automobile," including "cruise control").

82. Finally, a POSITA would have reasonably expected to succeed in combining the teachings of Hongo and Obradovich within a vehicle. Such a combination would have required only routine knowledge because the addition of Obradovich's interfaces to a vehicle with Hongo's adaptive cruise control would have involved small modifications of software that were well within the skill of a POSITA prior to the Critical Date. Obradovich recognized the existence of vehicle

systems that “provide[] audiovisual information in a number of modes...”

TESLA-1008, 1:16-28 (citing U.S. Pat. No. 5,404,443). Obradovich also teaches that “[v]oice command and touch screen techniques are frequently mentioned in prior art references in controlling car accessories.” *Id.* (citing U.S. pat. No. 5,214,707).

83. A POSITA would have been capable of incorporating combining the teachings of Obradovich and Hongo, as discussed above, into a vehicle without invention. Hongo and Obradovich also focus on a different well-known aspect of vehicle operation such that, in a vehicle incorporating Hongo and Obradovich, corresponding elements would have performed the functions described in each individual reference. As discussed above, elements of Hongo’s device 100 would have provided adaptive cruise control functionality (as taught in Hongo), while elements of Obradovich’s system 100 would have improved a user’s interaction with vehicle control systems to thereby enable more user-friendly vehicle operation.

2. Combination of Hongo and Niki

84. Hongo generally describes systems and techniques relating to adaptive cruise control, where a target speed of a vehicle is adjusted based on external road conditions. When combined with Niki, which describes a specific implementation of a hybrid vehicle with cruise control functionality, a vehicle incorporating the

teachings of Hongo and Niki makes obvious an electric vehicle with a power management system configured to apply a calculated electric power to the vehicle.

Id.

85. As discussed in Section V.A, Hongo states its invention relates to “a means for automatically outputting an optimized or optimized target vehicle speed according to weather, sunlight conditions, etc., which can change naturally and over time, in a target vehicle speed determining device.” TESLA-1005, [0007]. Further, “according to the present invention, it is possible to more easily (automatically) adapt the target vehicle speed to the road environment than before.” *Id.*, [0009]. These disclosures are not limited to a particular vehicle type, and absent any limiting disclosure in Hongo, a POSITA would have recognized that Hongo’s invention (e.g., “target vehicle speed determining device” or device 100) is applicable to any vehicle type. Such an interpretation would have advanced Hongo’s broader motivation of using adaptive cruise control to “ensure sufficient convenience.” *Id.*, [0006]. Consistent with Hongo’s broader teachings, a POSITA would have understood that device 100 may be implemented in different types of vehicles, including those with an internal combustion engines (ICEs), a hybrid engine (e.g., ICE, electric engine), and a fully electric engine.

86. A POSITA would have been motivated to implement Hongo’s teachings in a hybrid vehicle (e.g., Niki’s parallel hybrid vehicle) in the manner

discussed above because the implementation would have involved choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success. As discussed above, each of Hongo and Niki disclose using a calculated target speed in regulating a vehicle's traveling speed, which a POSITA would have understood is a finite and predictable solution for enabling cruise control functionality. TESLA-1005, [0008] (describing a "means for determining a target speed of the vehicle"); TESLA-1009, 8:47-67 (describing techniques relating to "the target value of the travelling speed of the vehicle"). Each reference describes similar mechanisms of enabling cruise control using a target vehicle speed. A POSITA would have found it predictable to implement, for example, Hongo's cruise control device 100 into the type of hybrid vehicle disclosed in Niki.

87. A POSITA would have also been motivated to combine the teachings of Hongo and Niki because Niki provides teachings and/or suggestions that improve vehicle control in the Hongo vehicle. Specifically, Niki teaches that its control unit 1 includes "a VSA (Vehicle Stability Assist) ECU 31 which drive controls the brake device 24 to stabilize the behavior of the vehicle," and "an ACMECU 32 which drive controls the damping device 19 to suppress the generation of car body vibration..." TESLA-1009, 8:6-24. A POSITA would have perceived these teachings enabling improved vehicle stability to be reasonably pertinent to Hongo's adaptive cruise control given Hongo's recognition that users

may have different “preferences regarding the degree of stability related to lateral G and the like.” TESLA-1005, [0022]. Aspects of Niki’s control apparatus (e.g., vehicle stability assist) would have thereby improved Hongo’s adaptive cruise control by reducing variability due to “individual differences” in driver-specific behaviors, such as “individual skill in steering wheel operation.” TESLA-1005, [0022].

88. A POSITA would have perceived functionality provided by Niki’s cruise control unit 53 to be reasonably pertinent to and/or compatible with that provided by Hongo’s device 100 since Hongo and Niki each focus on similar types of vehicle speed control using a target vehicle speed. TESLA-1005, [0008]; TESLA-1009, 8:47-59. In Niki, a “target vehicle speed” represents the “target value of the traveling speed of the vehicle” in a hybrid vehicle. TESLA-1009, 8:47-59. Hongo also focuses on using a “target vehicle speed V0” to achieve “accurate speed control.” TESLA-1005, [0068]. Hongo itself identifies prior art cruise control systems capable of “determin[ing] the target speed of a running vehicle.” TESLA-1005, [0002] (citing U.S. Pat. No. 6,161,072 and J.P. Pat. Pub. No. H820728 as examples). A POSITA would have found it obvious to implement Hongo’s device 100 in a hybrid vehicle and have reasonably expected to succeed in achieving such an implementation. This expectation is further bolstered by the fact that the cruise control functionality in Niki has the same input (e.g., vehicle

speed) and the same output (e.g., target vehicle speed) as the cruise control functionality of Hongo.

89. A POSITA would have also reasonably expected to succeed in combining the teachings of Hongo and Niki within a vehicle. Such a combination would have required only routine knowledge since, as described in Niki, control apparatuses for hybrid vehicles applied “conventional technique[s]” for regulating aspects of an internal combustion engine and an electric motor. TESLA-1009, 1:20-35. In Niki, a control apparatus of a “parallel hybrid vehicle” includes “cruise control unit 53,” demonstrating that cruise control functionality in a hybrid vehicle was also well-known by the Critical Date. TESLA-1009, 5:17-32, 8:47-59.

3. Analysis

(i) Claim 1

[1.pre] A method of electric vehicle operation, comprising:

90. Hongo discloses [1.pre] because the preamble is not limiting. The preamble of claim 1 is not limiting since nothing in [1.pre] breathes life into the remainder of claim 1. For example, nothing in [1.pre] limits any of the subsequently-recited features of claim 1, and none of the features recited in the body of claim 1 rely on the *electric vehicle operation* of [1.pre] for antecedent basis.

91. Hongo-Obradovich-Niki makes [1.pre] obvious even if the preamble were limiting. As discussed in Section VII.A.2, a POSITA would have understood and/or found obvious that benefits provided by Hongo’s “adaptive cruise control system” are applicable to different types of vehicle engines, including internal combustion engines (ICEs), hybrid engines (e.g., ICE, electric engine), and electric engines. TESLA-1005, [0007]. Niki further describes a hybrid vehicle with a cruise control unit 53 for providing setting a target vehicle speed in a similar manner as described in Hongo, establishing that cruise control functionality was a conventional feature of hybrid vehicles by the Critical Date. TESLA-1009, 5:17-32, 8:47-5. Hongo-Obradovich-Niki makes obvious a hybrid vehicle (*electric vehicle*) (e.g., Niki’s hybrid vehicle) would have been configured for cruise control operation (*operation*) (e.g., Hongo’s adaptive cruise control).

92. To the extent that iQar attempts to characterize claim 1 as being limited to fully electric vehicles, such a characterization incorrectly interprets the claims. Claim 2 depends from claim 1 and recites that “electric power can be derived from operation of an internal combustion engine.” Any interpretation that limits claim 1’s scope to fully-electric vehicles would therefore be incorrect as it would necessarily exclude *operation of an internal combustion engine*, as recited in claim 2.

93. Methods of hybrid vehicle operation are examples of a *method of electric vehicle operation* because hybrid vehicles are examples of electric vehicles. Hybrid vehicles utilize an electric motor for vehicle operation, e.g., to propel the vehicle, assist an internal combustion engine, or operate the vehicle independently at low speeds. *Id.* For example, Niki’s hybrid vehicle includes an electric motor (“motor M”) configured to receive power “during [a] power running operation (driving or assisting) of the motor M,” which is an example of a vehicle operation of an electric vehicle.” TESLA-1009, 5:33-54.

94. A POSITA would have also understood that hybrid vehicles are examples of electric vehicles because they incorporate an electric motor alongside a conventional internal combustion engine. The electric motor can assist the vehicle’s propulsion and operate independently at low speeds, reducing overall fuel consumption and emissions. While hybrid vehicles are not purely electric (e.g., fully-electric vehicles), these hybrid vehicles use electricity as part of their powertrain, making them a hybrid between traditional gasoline-powered cars and fully-electric vehicles.

95. Hongo’s optimization techniques in combination with Obradovich also render obvious the power application techniques recited in the body of claim 1. While the ‘399 patent discloses implementation examples directed to power optimization for the purpose of improving a vehicle’s fuel efficiency, the ‘399

patent makes clear that its purported invention is not limited to such implementations. *See* TESLA-1001, 6:46-49 (“The power supplied to the engine may **alternatively** be optimized based on other criterion. For example, the power supplied to the engine may be optimized with respect to **speed** or travel time.”). *See also id.*, 3:2-4 (disclosing that a fuel efficient speed is merely an example of “an optimal speed”); 6:58-60 (disclosing a broad view of “fuel” as “refer[ring] to any appropriate power source for the engine.”); 19:65 to 20:2 (“the same procedures may be used to determine a speed (or speeds) over the route to minimize or maximize other factors, and **are not limited to optimizing only fuel efficiency**.”). To avoid such limited applicability, the claims of the ‘399 patent make no mention of improving fuel efficiency. As shown in further detail below, Hongo’s power optimization techniques and systems, which account for diverse external conditions (e.g., weather, road surface temperature) and other information in adapting vehicle operation, in combination with Obradovich’s teachings render the claims of the ‘399 patent obvious not only because they satisfy all of the limitations of the ‘399 patent’s broad claims but also because they fall well within the scope of the ‘399 patent’s broadly characterized purported invention.

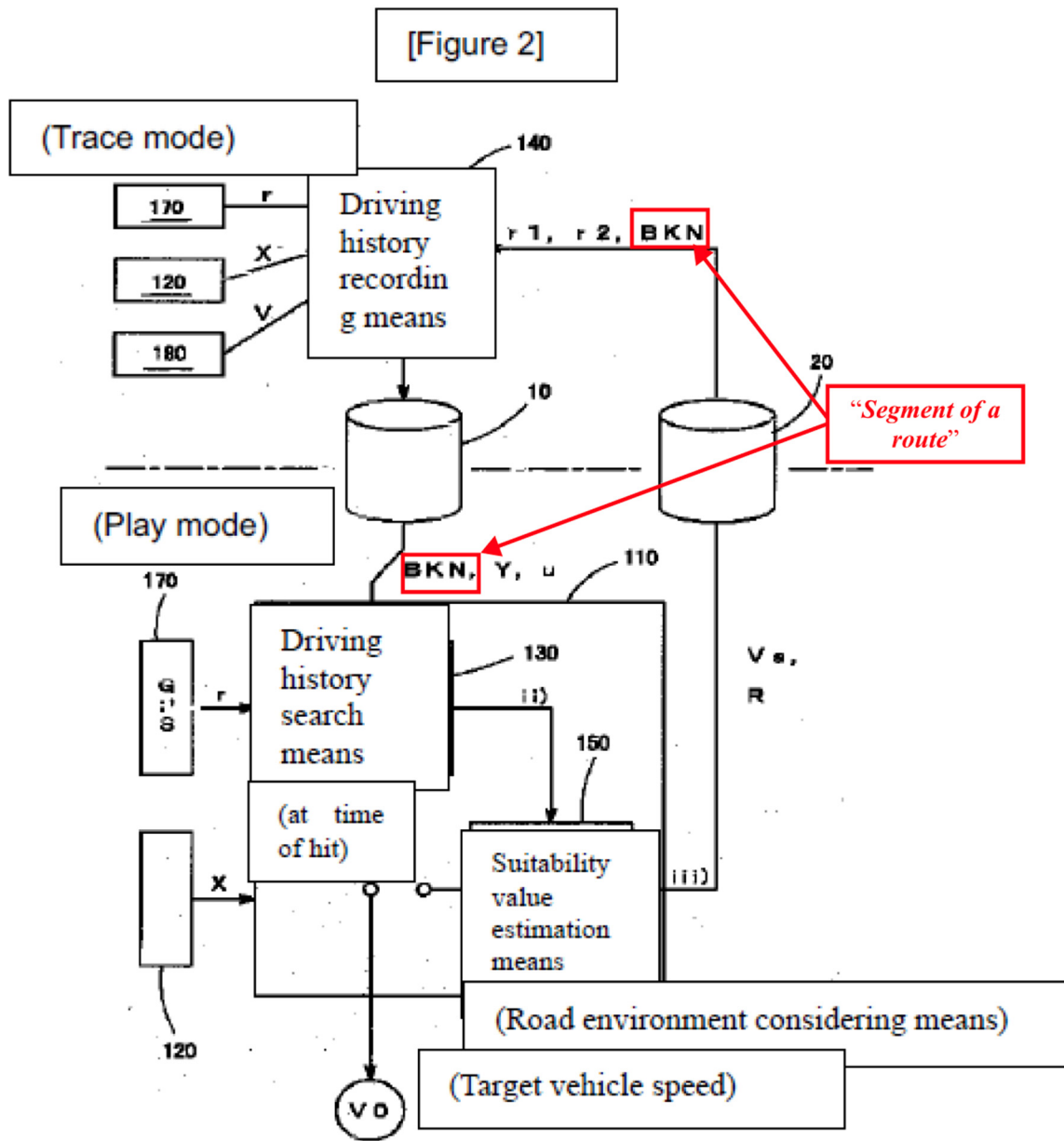
[1.a] *determining a segment of a vehicle route;*

96. As noted above, means 140 can “acquire[] position information (current position coordinates r) from the GPS 170, and the position of a driving

block (block number) that is defined by dividing [a route being driven on] into sections approximately every 20m in the driving direction on the road being driven on.” TESLA-1005, [0027].³ Hongo’s “driving block” discloses a *segment* of a travel direction on a road being traveled (*vehicle route*).

97. Hongo’s system identifies each block using a block number (BKN), as shown in the annotated FIG. 2 below:

³ While “trace” and “playback” modes are described in Hongo, a POSITA would have understood that Hongo contemplates implementations that include both modes. *See, e.g.*, TESLA-1005, [0025] (“[i]n the following embodiments, an implementation scheme having both a ‘trace mode’ and a ‘playback mode’ is disclosed.”). A POSITA would have therefore understood that embodiments of Hongo that include each mode render claim 1 obvious in combination with the teachings of Obradovich and Niki.



TESLA-1005, FIG. 2⁴

98. Specifically, “the block number BKN and the road environment parameter Y are specified from the current position coordinate r and the road environment real-time information X by a method equivalent to the above-

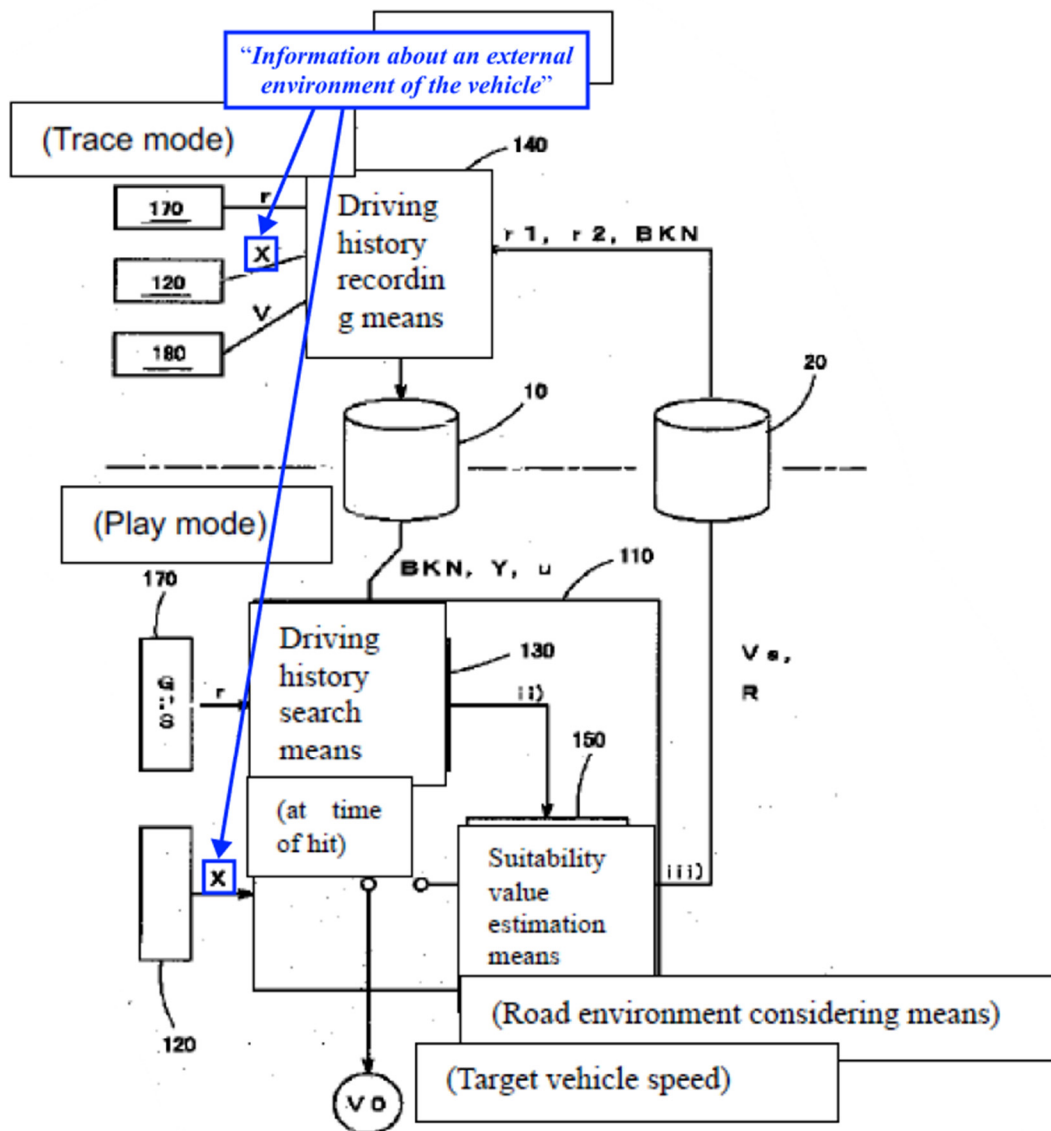
⁴ Annotations to the figures throughout this declaration are shown in color.

mentioned driving history recording means 140.” TESLA-1005, [0032]. Since the Hongo system identifies a “block” using information gathered by a travelling vehicle (“current position coordinate r,” “road environmental real-time information X”), Hongo discloses **determining** the block based on the gathered information.

[1.b.1] determining information about an external environment of a vehicle,

99. According to the '399 patent, the feature recited in this element (**information about an external environment of a vehicle**) encompasses “any information about the environment surrounding or acting on the vehicle.” *See, e.g.,* TESLA-1001, 7:52-65.

100. Hongo teaches that “various signals” may be monitored and used for “observing or estimating weather, sunlight conditions, etc.” and further to determine “road surface conditions” and “visibility conditions” from at least some of these signals. TESLA-1005, [0011]. In the data flow shown in Figure 2, means 140 obtains “road environment real-time information X” (**information about an external environment of a vehicle**), including “road surface temperature.” By processing the “road environment real time information X” after reception by environmental acquisition means 120, means 140 **determine[s]** the road environment real time information X.



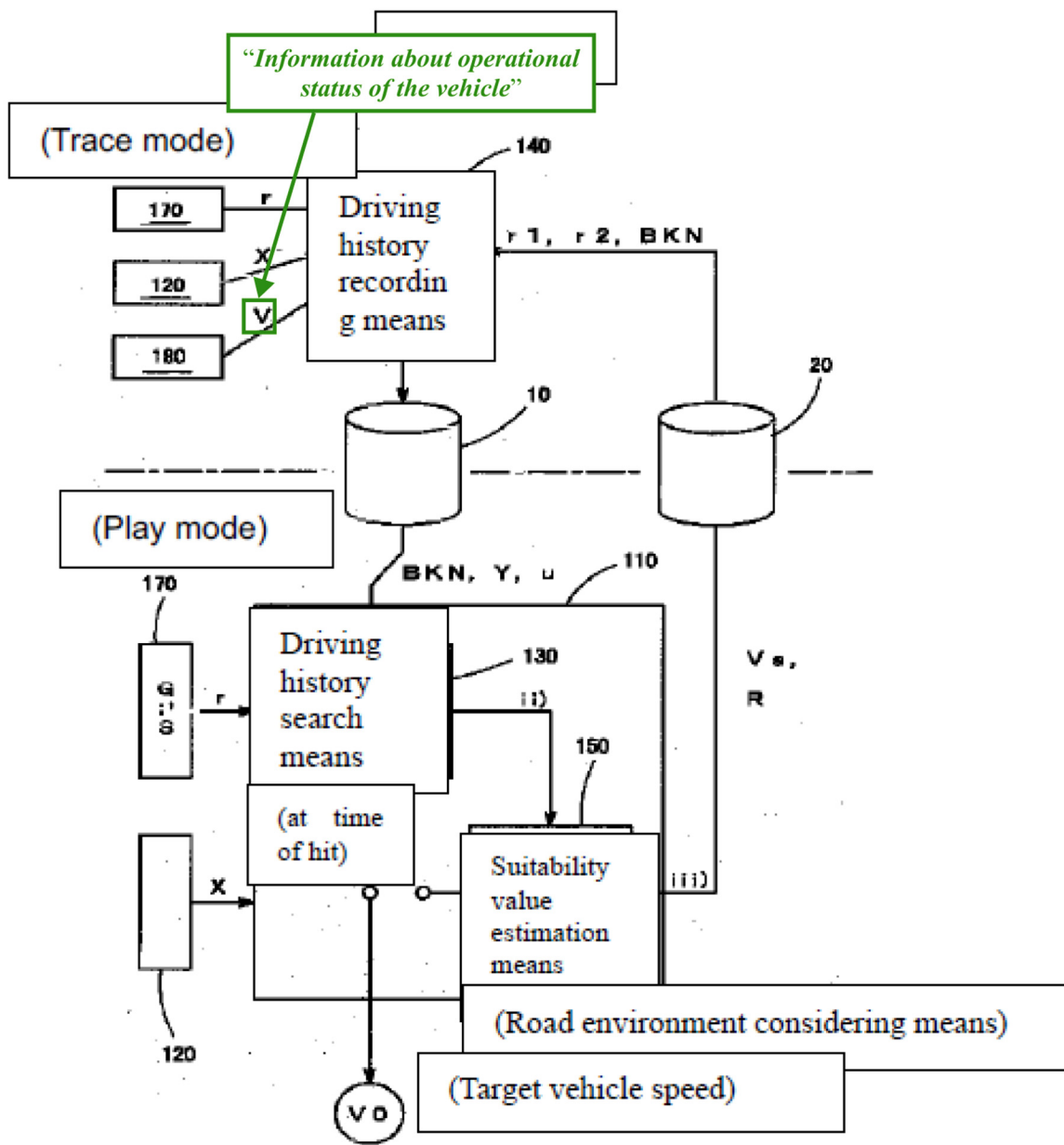
TESLA-1005, FIG. 2

[1.b.2] information about operational status of the vehicle,

101. According to the '399 patent, the feature recited in this element (*information about operational status of a vehicle*) encompasses "any information about the current operational status of the vehicle itself," such as information "used to determine the current condition of the vehicle's engine and component parts

(e.g., motor, powertrain, battery, tires, etc.), the current fuel supply, the manner in which the vehicle is traveling (e.g., velocity, acceleration, etc.), and the like.” *See, e.g.,* TESLA-1001, 8:53-61.

102. Hongo teaches that a vehicle includes a “vehicle speed sensor [180] that outputs a vehicle speed signal.” TESLA-1005, [0023]. In the data flow depicted in FIG. 2, the means 140 obtains “current vehicle speed V” (*information about operational status of the vehicle*) from the vehicle speed sensor 180. *Id.*, [0028]. By processing the “current vehicle speed V” in calculating the target speed, means 140 *determine[s]* the current vehicle speed. *Id.*



TESLA-1005, FIG. 2 (annotated)

[1.b.3] *information from external command input telemetry*

103. The '399 patent lacks reference to *external command input telemetry*. The '399 patent, however, does provide examples of *telemetry*. See, e.g., TESLA-1001, 3:55-4:57 (implementations of information being acquired by measurement

or input using “telemetry”); 8:33-35 (reception of “information by telemetry with off-board information sources such as databases and the like”); 24:49-59 (“telemetry system” includes “one or more external components,” such as “remote memory” and “database of information about route...”); *see also id.*, 3:55-4:57, 8:33-45, 24:39-59.

104. As to ***external command input***, the ’399 patent uses permissive language in disclosing examples of “command input.” *See, e.g.*, TESLA-1001, 9:27-40 (“[c]ommand inputs **generally include** any instructions from the driver of the vehicle about the operation (or intended operation) of the vehicle”)(emphasis added). These examples “are only intended to illustrate the kinds of command inputs that may be used” and “[a]ny appropriate command input may be provided to the power management device or used by the power management device.” *Id.*, 10:17-22. The ’399 patent further contemplates “command input” being “commands [provided] directly to the power management” and/or being “derived from other information including the environmental information and the operational status information.” TESLA-1001, 9:59-64. Consistent with the ’399 patent and these examples, ***external command input telemetry*** is broad enough to encompass telemetry instructions or telemetry used to derive instructions about a vehicle’s operation and is obtained from an external source.

105. A POSITA would have understood that an example of an external source that provides information corresponding to *information from external command input telemetry* is a computing device that is external to a vehicle. For example, U.S. Pat. No. 7,860,647 (“Amano”; TESLA-1020) describes a “server unit 500” (i.e., a remote system) that is “capable of acquiring various information from other server units...of various government offices such as Meteorological Agency and National Police Agency, private organizations, VICS and business enterprises via the network 300.” TESLA-1020, 27:61-28:9. The acquired information includes “various travel related information used during the travel of the vehicle such as weather information, VICS data including traffic jam, traffic accidents, constructions and traffic controls, and shop information about various shops including gasoline stations and restaurants etc.” *Id.*

106. A POSITA would have also understood that another example of an external source that provides information corresponding to *information from external command input telemetry* is a device that is external to a processing component that *appl[ies] calculated electric power to the vehicle to travel along the segment of the vehicle route at a calculated speed*, as recited in claim 1 (i.e., a device that is external to the *power management system* recited in claim 11). Based on this understanding, a POSITA would have recognized that a component of a vehicle that is external to a different component that calculates and applies a

target speed (and corresponding power) to the vehicle is an example of an external source that provides *information from external command input telemetry*. For example, in a vehicle incorporating Hongo-Obradovich-Niki, a POSITA would have understood that Obradovich's navigation system (e.g., "ACURA navigation system") is external to Hongo's device 100. TESLA-1008, 1:55-67, 5:23-32; TESLA-1005, [0025]. As discussed below for [1.c], in Hongo-Obradovich-Niki, device 100 provides adaptive cruise control and thereby *appl[ies] calculated electric power to the vehicle to travel along the segment of the vehicle route at a calculated speed*. In the combination, Obradovich's navigation system is external to device 100 within the vehicle, and therefore, an example of an external source that may provide *information from external command input telemetry*.

107. Hongo-Obradovich-Niki makes *external command input telemetry* obvious through various disclosures consistent with the examples of "command input" and "telemetry" described in the '399 patent. As one example, a vehicle incorporating certain implementations of the combination would have included Hongo's "radio," which receives information that "relates to road conditions," such as "traffic jams, traffic regulations, etc. during driving." TESLA-1005, [0064]. Additionally, "natural traffic jams, traffic accidents, road construction, construction around roads, large events, large holidays, etc. are factors that cause these changes[,]" and, "real-time received information from the radio is useful in

appropriately dealing with these real-time changes.” *Id.* A POSITA would have found it obvious that the traffic information received by the “radio” corresponds to *telemetry* because the received information represents, for example, measurement data relating to traffic jams and traffic accidents, where the measurement data is communicated wirelessly to a vehicle. TESLA-1005, [0064]. A POSITA would have further understood that the traffic information also corresponds to *external command input telemetry* because it relates to “environmental information” received from an external source and used in accordance with Hongo’s disclosure to derive a “preferred speed,” which the ’399 patent identifies as an example of a command input. TESLA-1001, 9:33-40 (“[e]xamples of command inputs include, but are not limited to:...preferred speed,...”); *see id.*, 9:61-64 (“...command inputs may be derived from other information including the environmental information...”); 7:66-8:16 (“Examples of environmental information inputs include, but are not limited to: ... traffic surrounding the vehicle ...”); TESLA-1005, [0064]. By processing signals received by the radio, Hongo-Obradovich-Niki *determine[s]* traffic information from the received signals (*information from external command input telemetry*).

108. As another example, a vehicle incorporating implementations of the combination would have included navigation functionality described in Obradovich, including “find[ing] the best route from [] digitized maps and

guid[ing] the driver therethrough via the voice interface.” TESLA-1008, 1:39-54.

This involves “receiv[ing] signals from a constellation of satellites which is part of the [global position system (GPS)]” and “verbally and visually communicating to the user instructions for reaching the destination.” *Id.*, 1:55-67. A POSITA would have found it obvious that these received GPS signals correspond to *telemetry* because, for example, they correspond to measurement data used to determine a current location of a vehicle, where the measurement data is communicated wirelessly to the vehicle. TESLA-1001, 3:55-4:15, 9:59-64.

109. In the above example discussed in the previous paragraph, “measurement data” corresponds to “data for measurement” (rather than data that is produced as a result of measurements) since the data (i.e., GPS signals received from satellites) is used to measure a current location of a vehicle (i.e., a location measured based on received GPS signals). This is consistent with a POSITA’s understanding of “[t]elemetry information” as “readings of spacecraft onboard sensors and software events circulating in the control loop and transmitted to a ground control center.” TESLA-1016, 3. Obradovich also supports this through recognition that “navigation systems were developed to help [users] reach their destinations,” and in particular, that “[a]fter a destination point is identified, [a] [navigation] system finds the best route from the digitalized maps and guides the driver therethrough via the voice interface, taking into account the latest traffic

conditions received by an FM receiver to avoid congestion.” TESLA-1008, 1:39-54.

110. The received GPS signals further correspond to *external command input telemetry* because they are used by the navigation system to derive, for example, “the vehicle’s known or predicted final destination” or “the vehicle’s known or predicted interim destination,” which the ’399 patent identifies as examples of command inputs. TESLA-1001, 9:33-39 (“Examples of command inputs include, but are not limited to: ..., the vehicle’s known or predicted final destination, the vehicle’s known or predicted interim destination, ...”); *id.* 1:55-67.

111. As described in Obradovich, “[i]n response to these signals, [a] navigation system pinpoints the automobile’s location (in latitude and longitude)[,]” and “also detects the automobile’s speed and direction.” TESLA-1008, 1:55-67. Using “geographic information stored on a hard disk in an onboard computer,” the navigation system is then “capable of verbally and visually communicating to the user instructions for reaching the destination.” *Id.* From this disclosure, a POSITA would have understood that the GPS signals received by the navigation system in Obradovich are used to derive a vehicle’s known or predicted final destination the vehicle’s known or predicted interim destination in a similar way as described in the ’399 patent.

112. The received GPS signals are related to “environmental information” received from an external source because they enable identification of “the current location of the vehicle,” which is then used by the navigation system to estimate “the destination (either a final or an intermediate destination)” of the vehicle. *Id.*, 9:61-66 (“In some variations, the command inputs may be derived from other information including the environmental information...”). For example, the “destination (either a final or an intermediate destination)” may be estimated based on “the current location of the vehicle. *Id.*, 7:66-8:16 (“Examples of environmental information include, but are not limited to: the current location of the vehicle, ...). By processing the received GPS signals, Hongo-Obradovich-Niki determines a vehicle location from the received GPS signals (*information from external command input telemetry*).

113. A POSITA would have understood that GPS signals received by a navigation system are used to identify intermediate destinations and/or a final destination associated with navigation. For example, if a user indicates that he/she wants to travel on a route to a particular restaurant, the route that is generated by the navigation system will use a current location to identify intermediate destinations in providing turn-by-turn directions to a final destination (i.e., a location of the particular restaurant). A POSITA would have recognized that this is why a current location is used by a navigation system to derive intermediate

destinations even if the user manually specifies only the final destination.

Obradovich indicates such a configuration of navigation systems was conventional by the Critical Date since it describes capabilities for “verbally and visually communicating to the user instructions for reaching the destination” (i.e., turn-by-turn instructions to a destination based on identifying intermediate destinations).

TESLA-1008, 1:55-67. Further, the use of a current location estimate (based on received GPS signals) in identifying intermediate and final destinations of a travel route was conventional by the Critical Date. *See, e.g.*, TESLA-1020, 4:60-5:13, 5:21-28, 11:18-38.

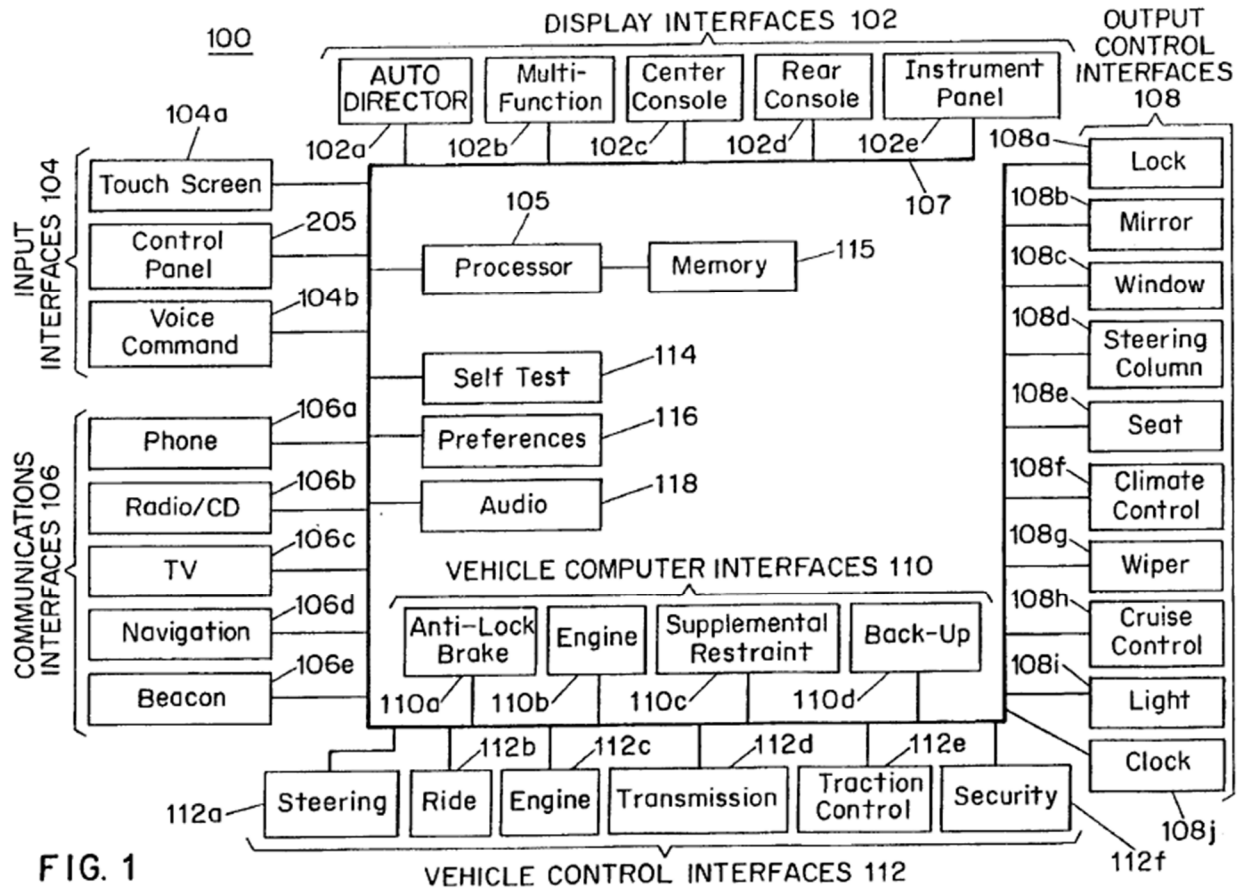
[1.b.4] *in combination with user command inputs to the vehicle including voice command inputs; and*

114. As discussed for [1.b.3], the '399 patent uses permissive language in disclosing examples of “command input.” *See, e.g.*, TESLA-1001, 9:27-40, 10:17-22. The '399 patent also states that “voice commands” are one example of “command inputs.” *See id.*, 4:34-45 (“[a]ny of [command input] information may be acquired by input (e.g., from an external telemetry, keyboard, mouse, voice command, a memory, etc.)”); 23:49-24:4 (“user commands may be accepted directly by using buttons on the user interface, or by voice commands.”).

115. Though Hongo does not specifically address *user command inputs* or *voice command inputs* provided by a user to the vehicle, a POSITA would have

perceived these features to be well-known in the relevant field of art as of the Critical Date. For example, Obradovich describes that voice interfaces for control vehicle functions were known in the art by its January 5, 1998 PCT filing date. *See, e.g.*, TESLA-1008, 1:39-54 (citing U.S. pat. No. 5,274,560 as an example of a system “based on artificial intelligence and provides a driver with directions via a voice interface”); 2:36-47 (identifying “a technique for controlling vehicle accessories via voice command is disclosed in U.S. Pat. No. 4,827,520”); 2:49-56 (“[v]oice command and touch screen techniques are frequently in prior art references in controlling accessories.”).

116. Obradovich also teaches a vehicle with “[i]nput interfaces 104,” including a “touch screen interface 104a” and a “voice command interface 104b.” TESLA-1008, 6:57-62. Voice command interface 104b is “connected a microphone...for processing voice commands by the user through the microphone to control or modify selected functions of system 100.” *Id.*



TESLA-1008, FIG. 1

117. Obradovich also describes a “[c]ruise control interface 108h” with “output control logic controllable by processor 105 to (1) turn the cruise control on or off, (2) set the vehicle speed, and (3) cancel or resume the set speed.” TESLA-1008, 8:16-18. Obradovich further notes that a POSITA would have recognized that “wherever the touch screen capability may be used to select or control various options or functions provided by system 100, the voice command is equally applicable.” *Id.*, 7:13-24. Obradovich discloses that the user can provide voice commands for controlling cruise control functionality via a cruise control interface

(user command inputs to the vehicle including voice command inputs), such as toggling cruise control on/off, setting a preferred vehicle speed, or cancelling/resuming the set vehicle speed.

118. Additionally, the use of voice commands to adjust control operations were well-known in the relevant field as of the Critical Date. For example, U.S. Pat. No. 6,420,975 (“DeLine”) is generally focused on audio systems for vehicles and describes that a vehicle can include a microphone 18, which can “function as a receiver for one or more [] vehicular functions and controls, such as voice activated headlamps, alarm systems, radios, **cruise control**, windows, cellular phones, message recorders, pagers, back up aids, windshield wipers, rain sensors and the like.” TESLA-1014, 10:54-11:14. The vehicle can include a “audio vehicle signal processor 330,” which acts as a “voice activated controller for a vehicle function,” e.g., “cruise control system.” *Id.*, 43:45-61.

[1.c] *applying calculated electric power⁵ to the vehicle to travel along the segment of the vehicle route at a calculated speed.*

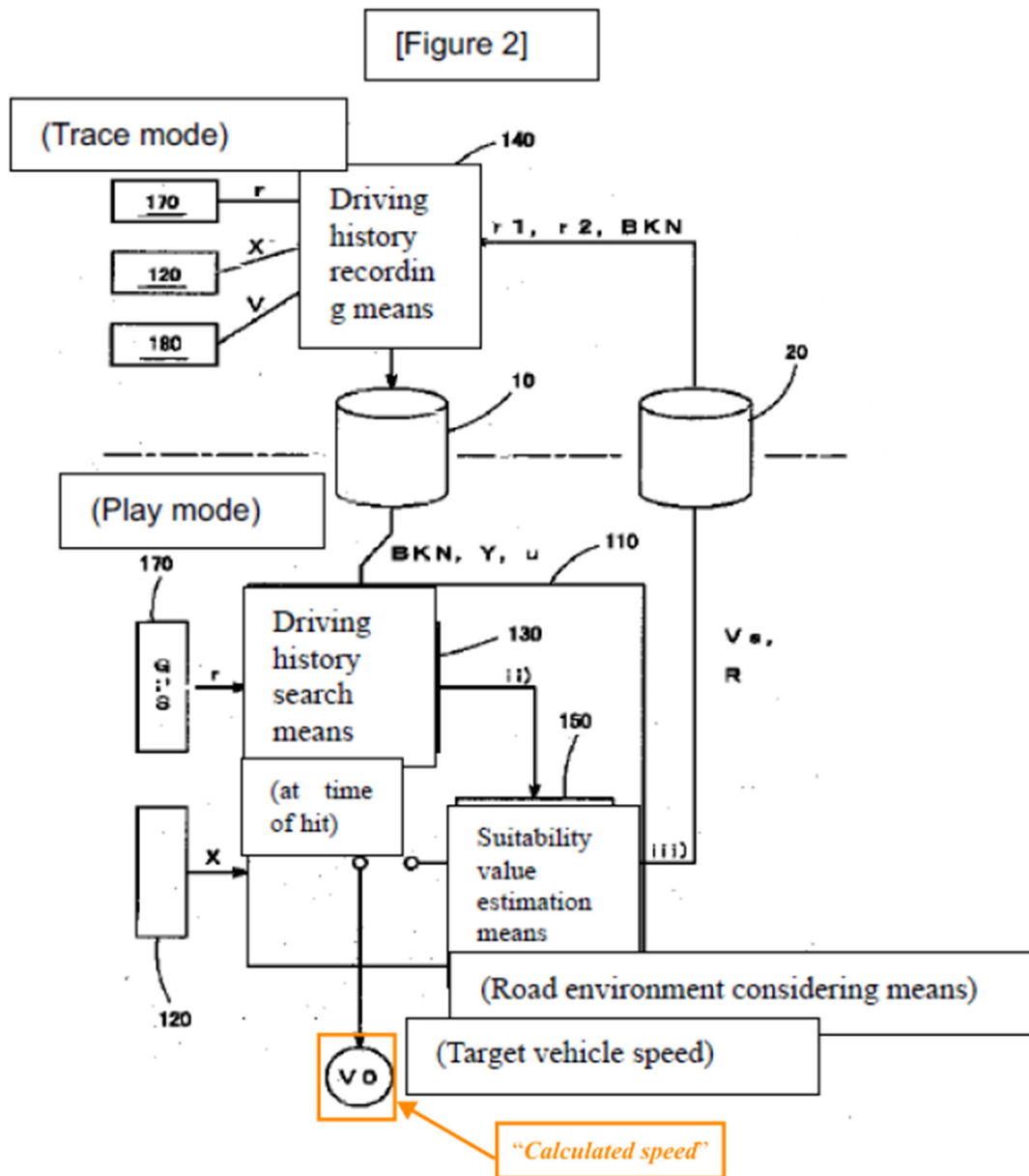
119. The operation in [1.c] (*applying calculated electric power...*) is recited in isolation from the four types of information recited in the preceding

⁵ Reference to *electric power* in [1.c] does not limit the scope of claim 1 to fully-electric vehicles. Claim 2 depends from claim 1 and recites that “*electric power*

limitations ([1.b.1]-[1.b.4]). Absent claim language to the contrary, under plain meaning, the operation recited in [1.c] encompasses an operation the performance of which is not tethered to or limited by the four types of information recited in [1.b.1]-[1.b.4]. As discussed below, Hongo-Obradovich-Niki discloses each of the elements of [1.c] under plain meaning. To the extent that the prior art teachings are deemed insufficient to disclose these elements, the combined disclosures of Hongo-Obradovich-Niki render them obvious.

120. As to *calculated speed*, the data flow depicted in Hongo's Figure 2 (below), means 140 and unit 110 operate in conjunction to calculate a "target vehicle speed V0" (*calculated speed*).

can be derived from operation of an internal combustion engine."



TESLA-1005, FIG. 2

The value of the “target vehicle speed V_0 ” is calculated, for example, using one of the equations/formulas taught in Hongo. TESLA-1005, [0035] (formula 1), [0036] (Formula 2), [0055] (Formula 3). The target speed value V_0 is used for adaptive cruise by outputting the calculated value to a “ACC system 200.” TESLA-1005,

[0024]; *see id.*, [0054].

121. As to *applying calculated electric power to the vehicle*, Hongo-Obradovich-Niki satisfies this element by using target vehicle speed to adapt cruise control in a hybrid vehicle. For example, a POSITA would have understood that controlling vehicle movement using the target vehicle speed itself involves calculating and applying a power corresponding to the target vehicle speed to the vehicle engine. The '399 patent supports this through disclosure that applying an “optimally efficient speed” is one way of applying “optimal power” to the engine. TESLA-1001, 2:30-63 (“[t]he applied power may also be expressed as an optimized speed or speeds to which the vehicle is controlled”).

122. As another example, a POSITA would have understood, based on the '399 patent, that power can be derived from a target vehicle speed applied to a vehicle. For example, as shown in Figure 2, step 205 involves calculating a “model optimal speed (or power),” prior to “the overall efficient applied power [being] provided to the engine.” TESLA-1001, 11:44-62. From this disclosure, a POSITA would have recognized that an “optimal speed” can be used to derive “optimal power” and thereby apply the derived optimal power to the vehicle.

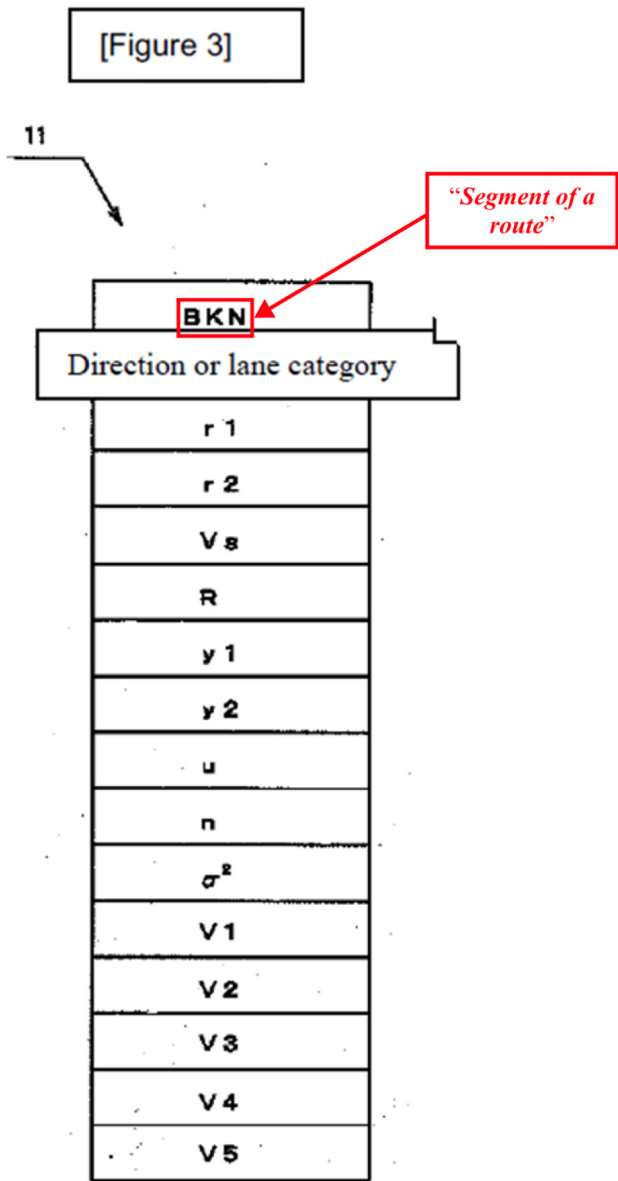
123. As to the power being a *calculated electric power*, Hongo-Obradovich-Niki would have provided adaptive cruise control in a hybrid vehicle, which involves adapting the power of an electric engine. In Niki, “cruise control”

enables “constant traveling control” by “control[ling] the internal combustion-engine E **and the motor M** so that the vehicle travelling speed VP detected in a vehicle speed sensor S1 becomes the target vehicle speed...” TESLA-1009, 8:47-59 (emphasis added); *see id.*, 5:17-54 (“motor M” can be “a three-phase brushless DC motor or the like” and is “connected to a power drive unit (PDU) 2”). Since adaptive cruise control in Hongo-Obradovich-Niki would have enabled applying a power to an electric motor of a hybrid vehicle (applying a *calculated electric power*).

124. A POSITA would have also understood that in a vehicle incorporating Hongo-Obradovich-Niki (i.e., a hybrid vehicle) may be configured such that an internal combustion engine generates mechanical power to propel the vehicle, while the electric motor generates electrical power. The key distinction between a hybrid and a fully electric vehicle is that the electric motor in a hybrid assists the ICE and does not solely power the vehicle. This combination of mechanical and electrical power allows hybrids to improve fuel efficiency and reduce emissions compared to conventional gasoline-only vehicles.

125. As to the application of power to enable the vehicle *to travel along the segment of the vehicle route*, Hongo-Obradovich-Niki would have provided adaptive cruise control as a vehicle is traveling along a route. In Hongo, the “target speed” is “determined based on the past driving history in which both the position

and the road environment real-time road information match.” TESLA-1005,
[0017]. Since the “target speed” is calculated based on means 140 determining a
block number BKN identifying a driving block in the driving block DB 20, the
“target speed” is calculated for the driving block (*segment of the vehicle route*).
For example, Figure 3 shows examples of information stored for a particular
driving block in association with the block number BKN in driving history DB 10:



TESLA-1005, FIG. 3

126. Hongo further indicates that the stored information shown above is used to calculate a value of the target vehicle speed. For example, “Direction or Lane Classification” is used for “classifying the current direction of travel (up/down, etc.) on the road being driven on.” TESLA-1005, [0029]. As discussed

above, the “block range coordinates (r1, r2),” are compared against a “current position r” of a vehicle in relation to adaptive cruise control. *Id.*, [0045].

Additionally, “weather code y1 and sunshine code y2” are used to derive the “road environment parameter Y” shown in Figure 2, and “u is the average value of valid vehicle speed data,” which, in some instances, “can be used as is, as the target vehicle speed V0 in the later reproduction mode.” *Id.*, [0029]. From these disclosures, a POSITA would have understood that the ACC system 200 adjusts power output of the vehicle *to travel along the segment of the vehicle route at a calculated speed.*

127. As discussed above, Hongo-Obradovich-Niki discloses each of the elements of elements of [1.c] under plain meaning. However, if the prior art teachings discussed above are deemed insufficient to disclose the elements of [1.c], the overall disclosures of Hongo, and Obradovich and Niki, makes those elements obvious. A POSITA would have found it obvious that implementing adaptive cruise control in a hybrid vehicle involves regulating power to a vehicle engine in order to maintain a target vehicle speed (or velocity) of the vehicle. A POSITA would have known that vehicle power output and vehicle speed are directly correlated. *See* TESLA-1018, 157, 167-68. Specifically, vehicle power output and speed are directly correlated because power is the rate at which work is done, and in the context of a vehicle, power is the product of engine torque and rotational

speed (RPM). As a vehicle's speed increases, the vehicle engine produces more power to overcome aerodynamic drag and other resistive forces to maintain or accelerate that speed. This direct relationship between power and speed is therefore determines a vehicle's performance capabilities.

128. Additionally, disclosures within the '399 patent also render obvious that applying a target speed to a vehicle involves applying a corresponding power to the vehicle, or that the power may be derived from a value of target speed. *See* TESLA-1001, 2:30-63 (“[t]he applied power may also be expressed as an optimized speed or speeds to which the vehicle is controlled”), 11:44-62 (calculating a “model optimal speed (or power)” prior to “the overall efficient applied power [being] provided to the engine”).

129. To the extent that the operation recited in [1.c] (*applying calculated electric power*) is deemed limited by some or all of the information [1.b.1]- [1.b.4], Hongo-Obradovich-Niki also discloses and makes these narrowing interpretations obvious. For example, as discussed above, target speed is calculated based on “road environment real time information X” (*information about an external environment of a vehicle*) (*see* [1.b.1]), “current vehicle speed” (*information about operational status of the vehicle*) (*see* [1.b.2]), and “traffic information” (*information from external command input telemetry*) (*see* [1.b.3]). A POSITA would have understood that applying power relating to adaptive cruise control

(applying calculated electric power to the vehicle) is based on “road environment real time information X,” “current vehicle speed” and “traffic information” because Hongo teaches using these information to calculate and apply a target vehicle speed (which, as discussed above, has a corresponding power). TESLA-1005, [0017], [0029], [0045]. Additionally, the value of the target speed is used to adapt cruise control functionality is directly correlated with power output). As discussed above, vehicle power output and speed are directly correlated because power is the rate at which work is done, and in the context of a vehicle, power is the product of engine torque and rotational speed (RPM).

130. Additionally, as discussed above in [1.b.4], in Hongo-Obradovich-Niki, a vehicle incorporates Hongo’s adaptive cruise control system and vehicle componentry described in Obradovich, such as processor 105, voice command interface 104b, and cruise control interface 108h. As described in Obradovich, cruise control interface 108h includes output control logic controllably by processor 105, and in some implementations, the control is provided by voice command. The controls include turning the cruise control on/off, setting the vehicle speed, and canceling/resuming the set speed. Hongo-Obradovich-Niki would have enabled certain scenarios in which a user provides a voice command to enable adaptive cruise control. In such scenarios, a POSITA would have understood that the target speed is calculated based on “road environment real time

information X” (*information about an external environment of a vehicle*) (see [1.b.1]), “current vehicle speed” (*information about operational status of the vehicle*) (see [1.b.2]), “traffic information” (*information from external command input telemetry*) (see [1.b.3]), and a voice command enabling cruise control (*user command inputs to the vehicle including voice command inputs*) (see [1.b.4]).

(ii) *Claims 2, 5, 6, 9, 10*

[2] *The method of claim 1, wherein electric power can be derived from operation of an internal combustion engine.*

131. As discussed for [1.pre], Hongo’s disclosure is non-limiting as to vehicle type. A POSITA would have understood and/or found obvious that benefits provided by Hongo’s “adaptive cruise control system” are applicable to different types of vehicle engines, including internal combustion engines (ICEs), hybrid engines (e.g., ICE, electric engine), and electric engines. In at least some implementations where Hongo’s device 100 is implemented in a vehicle with an internal combustion engine, adjusting power control to enable adaptive cruise control satisfies [2] under plain meaning. For example, Niki describes use of regenerative braking, which a POSITA would have understood may involve recharging a battery associated with an electric engine. TESLA-1009, 5:17-54.

132. A POSITA would have recognized regenerative braking in a hybrid vehicle involves the conversion of kinetic energy into electrical energy during deceleration or braking. While the primary source of power in a hybrid vehicle is

the internal combustion engine, the electric motor can act as a generator during braking events, capturing some of the kinetic energy of the vehicle and converting the kinetic energy into electrical power. This electrical energy is then stored in the vehicle battery and can be used to assist the vehicle during acceleration, demonstrating how, in hybrid vehicles configured to provide regenerative braking, electric power can be derived from the operation of the internal combustion in certain circumstances.

[5] *The method of claim 1, further comprising the step of selecting a destination by at least one of a driver and a passenger.*

133. As discussed above, a POSITA would have implemented Hongo-Obradovich-Niki such that the vehicle incorporating the combination includes Hongo's device 100 and Obradovich's system 100. This implementation would have improved the overall driving experience, e.g., by enabling the use of voice commands to control adaptive cruise control while driving using Obradovich's voice command interface 104b and cruise control interface 108h.

134. Obradovich generally recognizes that use of navigational systems in vehicles were conventional as of its 8/28/2001 filing date (i.e., by the Critical Date). *See* TESLA-1008, 1:39-54 (noting that "navigation Systems were developed to help reach their destinations in an unfamiliar milieu," e.g., U.S. Pat. No. 5,274,560, which described use of "artificial intelligence and provides a driver

with directions via a voice interface”). Obradovich also describes that its system 100 includes “communications interfaces 106,” including a “navigation interface 106d.” *Id.*, 6:63-7:7. The “navigation interface 106d” is “connected to a standard inertial guidance system...capable of providing gyros information, and deriving the vehicle location based on GPS information.” *Id.*, 7:26-35.

135. In one example, Obradovich describes a “NAVIGATION option 401” shown on a user interface. TESLA-1008, 12:60-13:10. In this example, upon activation of option 401 by a user, system 100 “enter[s] into a navigation mode” where “processor 105 causes navigational instructions to be displayed on screen 209 in a conventional manner.” *Id.* In this mode, “the system is capable of visually and verbally providing the user with directions to a given destination through AUTO DIRECTOR display interface 102a and audio interface 118, respectively.” *Id.* In at least this example, Obradovich teaches that system 100 identifies a given destination associated with route guidance (*selecting a destination*) where the identification is based on a user activating the navigation mode (*by at least one of a driver and a passenger*).

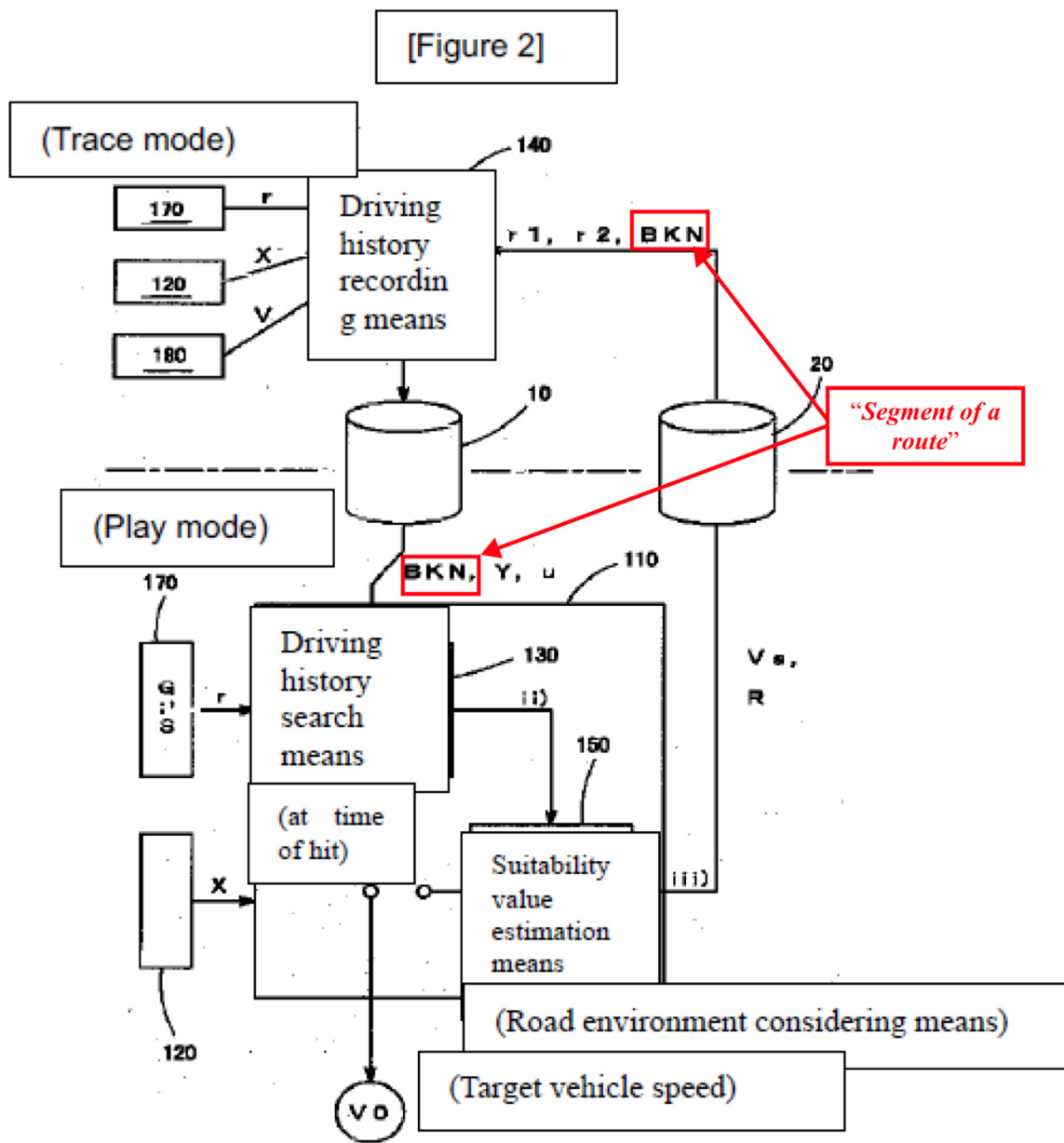
[6.1] *The method of claim 1, wherein vehicle route segment determination further comprises determining multiple route segments,*

136. As discussed for [1.a], means 140 “acquires position information (current position coordinates r) from the GPS 170, and the position of a driving

block (block number) that is defined by dividing it into sections approximately every 20m in the driving direction on the road being driven on is identified.”

TESLA-1005, [0027]. Hongo’s “block” discloses a *segment* of a travel direction on a road being traveled (*vehicle route*). Given that each block is a 20m portion, a POSITA would have understood and/or found obvious that, in some scenarios, a route includes multiple driving blocks (*determining multiple route segments*).

137. Hongo’s system identifies each block using a block number (BKN), as shown in the annotated FIG. 2 below:



TESLA-1005, FIG. 2

138. A “block number BKN and the road environment parameter Y are specified from the current position coordinate r and the road environment real-time information X by a method equivalent to the above-mentioned driving history recording means 140.” TESLA-1005, [0032]. Since the Hongo system identifies a

particular “block” amongst multiple blocks identified in a database using information gathered by a traveling vehicle (“current position coordinates r,” “road environmental real-time information X”), Hongo discloses **determining** multiple blocks based on the gathered information.

[6.2] *each route segment having a separate calculated speed and selected drive train parameters.*

139. As noted above, Hongo’s means 140 “acquires position information (current position coordinates r) from the GPS 170, and the position of a driving block (block number) that is defined by dividing it into sections approximately every 20m in the driving direction on the road being driven on is identified.”

TESLA-1005, [0027]. Hongo’s “driving block” discloses a **route segment**.

140. Hongo describes various examples of techniques for computing a target speed. *See* TESLA-1005, [0033]-[0042]. In one example, “[i]f block number BKN misses,” the target vehicle speed V_0 is calculated using equation

“ $V_0 = (V_s \times \gamma) \times \alpha_2 \times \beta_2$,” where “ $\gamma = f(R, V_s) \dots (2)$.” TESLA-1005, [0036]. In this

example, “the value of γ is given by a predetermined function f based on (the minimum value of) the radius of curvature R of the corresponding driving block.”

Id., [0037]. Additionally, “when $R \rightleftharpoons \infty$ (when the road is straight), $\gamma = 1$, and the value of γ monotonically increases and decreases with R .” *Id.* As discussed above for [1.c], “driving block DB 20” is a database that stores “block number BKN”

along with “block range coordinates (r1, r2) of each driving block, the legal speed limit Vs of the driving block, the **minimum radius of curvature R** of the driving block, and the like...” *Id.*, [0027] (emphasis added).

141. In the example discussed above, POSITA would have found it obvious that, in at least some circumstances where a vehicle travels a on curved path, Hongo’s system computes a target speed for each driving block of the curved path (*each route segment having a separate calculated speed*). Indeed, Hongo recognizes that “the radius of curvature R is a parameter that can change suddenly as the vehicle advances, so it is desirable to look ahead at the required number of cases and determine the argument (independent variable R) of the function f by aiming at the smallest value among them.” TESLA-1005, [0039]. From this disclosure, a POSITA would have found it advantageous that Hongo’s system computes a target vehicle speed for each road segment (driving block) to account for any sudden changes to the curvature R along the travel path. As discussed above, in these scenarios, the target vehicle speed V0 is calculated using equation “ $V0=(Vs \times \gamma) \times \alpha^2 \times \beta^2$,” where “ $\gamma=f(R, Vs) \dots (2)$.” *Id.*, [0036]. Moreover, a change in the radius of curvature R between road segments produces a different value of coefficient, γ , for each road segment, which then produces a different calculated target speed for each road segment.

142. A POSITA would have found it obvious that Hongo's adaptive cruise control involves adjusting vehicle speed using parameters associated with the target speed, for example, a vehicle speed parameter or an engine power management parameter (*selected drive train parameters*). Adaptive cruise control functionality involves adjusting drive train parameters, such as "gear shifting to decelerate [a] host vehicle..." TESLA-1017, 15. As another example, a POSITA would have understood and found obvious that Hongo's adaptive cruise control maintains the target speed by adjusting throttle position parameters (*selected drive train parameters*), which influences engine power output. This is because throttle management is a key aspect of drivetrain functionality. As yet another example, in vehicles with automatic or semi-automatic transmissions, a cruise control system can signal a transmission to shift gears to maintain the desired speed, especially when driving conditions change (e.g., going uphill).

[9] *The method of claim 1, wherein voice command inputs are provided to the vehicle by a separate source.*

143. As recited, *separate source* is a relative term, but the claim language in claims 1 and 9 does not identify another element from which this element is *separate*. Likewise, given the lack of further detail in claims 1 and 9, the claim language encompasses different configurations of sources considered to be physically or logically separate. Given such ambiguity, a POSITA would have

looked to claim language recited in other claims to understand the scope of [9]. In doing so, a POSITA would have recognized that independent claim 11 recites each of a *user interface system* that is *capable of accepting voice command inputs* and a *power management system* set to *calculate electric power and speed over a segment of a vehicle route*. A POSITA would have recognized that this configuration recited in claim 11 is an example that satisfies the requirement in [9] that *voice command inputs are provided to the vehicle by a separate source* in that the *voice commands inputs* (recited in [1.b.4] and [9]) are provided to a vehicle by a first component that is different from a second component that *appl[ies] calculated electric power to the vehicle* (recited in [1.c]).

144. As discussed above, a POSITA would have implemented Hongo-Obradovich-Niki such that a vehicle incorporating the combination includes Hongo's device 100 and Obradovich's system 100. This implementation would have improved the overall driving experience, e.g., by enabling the use of voice commands to control adaptive cruise control while driving using Obradovich's voice command interface 104b and cruise control interface 108h.

145. As discussed for [1.c], Hongo discloses that a device 100 calculates a "target speed" for "adaptive cruise" and outputs a calculated value to a "ACC system 200." TESLA-1005, [0003], [0024], [0054]. As discussed for [1.b.4], Obradovich discloses that a user can provide voice commands via a voice

command interface 104b to control cruise control functionality via a cruise control interface 108h. In a vehicle incorporating Hongo-Obradovich-Niki, Hongo's device 100 (specifically, means 140 and unit 110) uses target speed to adapt cruise control (which involves *applying calculated electric power to the vehicle to travel...at a calculated speed*) and Obradovich's system 100 (specifically, voice command interface 104b) receives voice commands for controlling cruise control functionality (*user command inputs to the vehicle including voice command inputs*). Since different devices and/or components of Hongo-Obradovich-Niki are involved in adaptive cruise control and voice command processing, the voice commands *are provided to the vehicle by a separate source*.

146. In Obradovich, a "voice command interface 104b" is "connected to a microphone" and includes "standard voice command circuitry...for processing voice commands by the user through the microphone to control or modify selected functions of system 100." TESLA-1008, 6:56-62. A POSITA would have found obvious that, in Hongo-Obradovich-Niki, a user (or the microphone) providing a command input is an example of a *source* of *voice command inputs* such that the user (or the microphone) is a *separate source* relative to device 100 (which *appl[ies] calculated electric power to the vehicle*, as recited in [1.c]). For example, a user that is providing a command input is a data source that is separate from device 100, which adjusts a target speed of the vehicle.

[10] *The method of claim 1, wherein voice command inputs are provided to the vehicle by a device having GPS functionality.*

147. As discussed above, a POSITA would have implemented Hongo-Obradovich-Niki such that the vehicle includes Hongo's device 100 and Obradovich's system 100. This implementation would have improved the overall driving experience, e.g., by enabling the use of voice commands to control adaptive cruise control while driving using Obradovich's voice command interface 104b and cruise control interface 108h. In Hongo-Obradovich-Niki, a vehicle includes Obradovich's system 100 (*device*).

148. Obradovich also describes that system 100 includes a "navigation interface 106d" that is "connected to a standard inertial guidance system (not shown) capable of providing gyros information, and deriving the vehicle location based on GPS information." TESLA-1008, 7:26-35. Additionally, "[b]esides the locational information, local and national emergency information may be derived from the GPS information using additional standard decoding circuitry in interface 106d." *Id.* Obradovich's system 100 is configured to have functionality to derive vehicle location based on GPS information (*GPS functionality*).

149. As discussed for [1.b.4], Obradovich's system 100 includes a voice command interface 104b to receive voice commands that control a cruise control interface 108h (*user command inputs to the vehicle including voice command*

inputs), such as toggling cruise control on/off, setting a vehicle speed, or cancelling/resuming the set vehicle speed. Obradovich's system 100 includes "[o]utput control interfaces 108" with "output control logic" to control various vehicle interfaces, including cruise control interface 108h. TESLA-1008, 7:39-43; *see also id.*, 8:16-19. In processing voice commands to control cruise control, Obradovich's system 100 (*device*) is configured to *provide[]* the voice commands to the automatic cruise control system 200 (*to the vehicle*) via cruise control interface 108h.

150. In Obradovich, a "phone interface 106a" enables connectivity between a vehicle and "standard phone equipment." TESLA-1008, 6:63-7:7. Further, "the user may operate the phone equipment via voice command, thereby realizing hands-free operation of the equipment." *Id.* A POSITA would have found obvious that, in Hongo-Obradovich-Niki, a standard phone equipment connected to a vehicle through a phone interface 106a is an example of **a device having GPS functionality** since GPS functionality was a well-known feature of phones by the Critical Date. Mobile devices having GPS functionality as a well-known configuration by the Critical Date. *See, e.g.*, TESLA-1019, [0014], [0017].

(iii) *Claim 11*

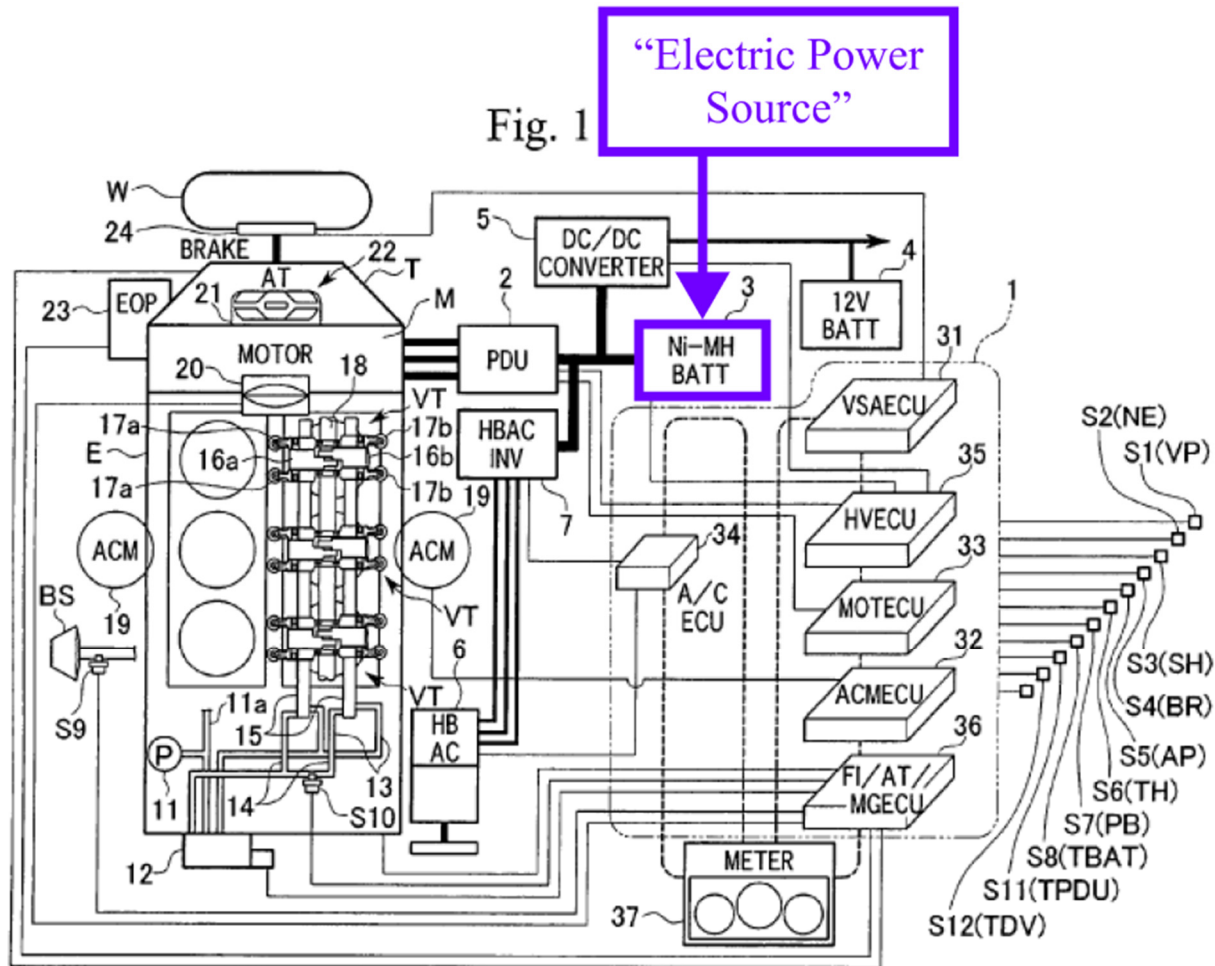
151. Hongo-Obradovich-Niki makes claim 11 obvious in the same manner as explained above for the corresponding claim 1 limitations below and based on the same corresponding evidence.

Claim 11 Limitation	Corresponding Limitation
[11.pre]	[1.pre]
[11.b.2]	[1.b.1]
[11.b.3]	[1.b.2]
[11.b.4]	[1.b.3]
[11.b.5]	[1.b.4]
[11.c.2]	[1.c]

[11.a.1] *a vehicle having an electric power source,*

152. As discussed for Section VI.A.2, a POSITA would have implemented in Hongo-Obradovich in Niki's hybrid vehicle. This configuration would have incorporated the vehicle componentry, described in Niki, including a "internal-combustion engine E, a motor M, and a transmission T [] connected directly in series." TESLA-1009, 5:17-32. Niki further describes that "motor M" may be a "three-phase brushless DC motor" that is "connected to a power drive unit (PDU) 2," which is further connected to a "nick-hydrogen battery (battery) 3 of a high voltage system which transfer the power for the motor M (the power supply which

is supplied to the motor M during [a] power running operation (driving or assisting) of the motor M...” *Id.*, 5:33-54. Hongo-Obradovich-Niki would have included battery 3 (*electric power source*) for supplying power to motor M (i.e., an electric motor).



TESLA-1009, FIG. 1 (annotated)

[11.a.2] *a communication system, and*

153. As discussed for [1.b.4], a POSITA would have been motivated to implement Hongo-Obradovich-Niki in a vehicle such that the vehicle includes

Hongo's adaptive cruise control system and vehicle componentry described in Obradovich.

154. Obradovich teaches a vehicle with “[c]ommunications interfaces 106,” including a “phone interface 106a, radio/CD interface 106b, television (TV) interface 106c, navigation interface 106d, and beacon interface 106e.” TESLA-1008, 6:63-7:7. A POSITA would have understood that a vehicle implementing Hongo-Obradovich-Niki would have included Obradovich's “communications interfaces 106” (*communication system*).

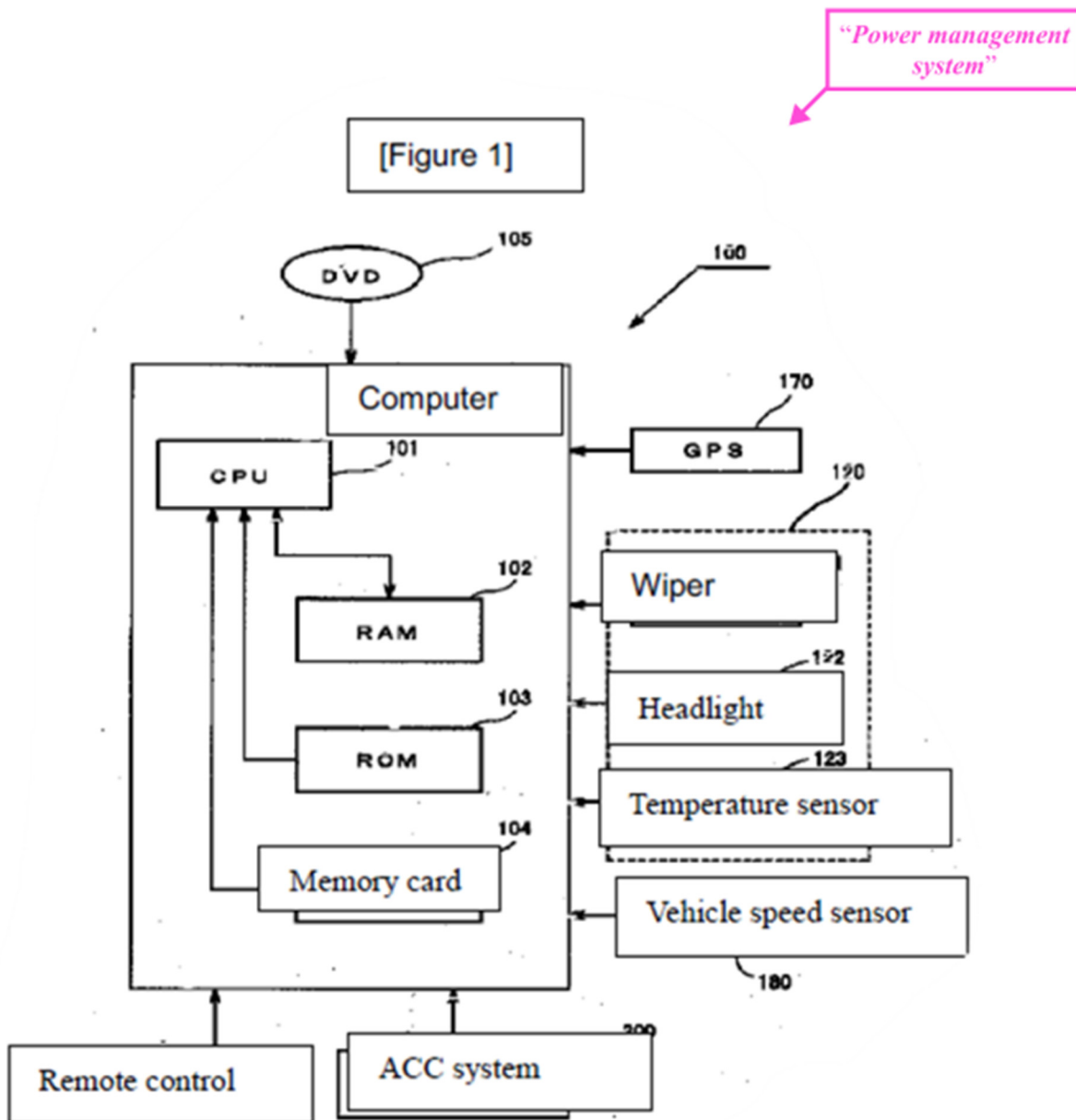
[11.a.3] a user interface system capable of accepting vehicle command inputs; and

155. As discussed for [1.b.4], Obradovich teaches a vehicle with “[i]nput interfaces 104” (*user interface system*) including a “touch screen interface 104Aa” and a “voice command interface 104b.” TESLA-1008, 6:57-62. Voice command interface 104b is “connected a microphone...for processing voice commands by the user through the microphone to control or modify selected functions of system 100.” TESLA-1008, 6:57-62. A POSITA would have understood and/or found obvious that a vehicle implementing Hongo-Obradovich-Niki would have included Obradovich's “communications interfaces 106.” Additionally, input interfaces 104 are *capable of accepting vehicle command inputs* because, as discussed for

[1.b.4], '399 patent describes that “voice commands” are an example of “command inputs.” TESLA-1001, 4:34-45, 23:49-24:4; TESLA-1008, 1:39-54, 6:57-62.

[11.b.1] *a power management system for the electric power source able to*

156. A POSITA would have understood and/or found it obvious that a vehicle incorporating Hongo-Obradovich-Niki includes a system (*power management system*) configured to apply a target speed (and corresponding speed) to adapt cruise control (as described in Hongo). For example, as shown in FIG. 1, the system would have included at least the vehicle speed determining device 100 and ACC system 200. TESLA-1005, [0029], [0035], [0036], [0045], [0055].



TESLA-1005, FIG. 1

157. The system shown above in Hongo's Figure 1 (in a vehicle incorporating Hongo-Obradovich-Niki) is a *power management system* because Hongo teaches calculating and applying a target speed to a vehicle in providing adaptive cruise control. TESLA-1005, [0029], [0035], [0036], [0045], [0055]. As

previously explained for [1.c], Hongo's technique of calculating and applying a target speed to a vehicle involves applying a corresponding power to the vehicle power output and vehicle speed are directly correlated. TESLA-1018, 157, 167-68. A POSITA would have understood Hongo's system 100 as a system that manages power relating to adaptive cruise control (*power management system*). TESLA-1001, 2:30-63, 11:44-62.

158. As discussed for [11.a.1], Hongo-Obradovich-Niki would have provided a hybrid vehicle with battery 3 (*electric power source*) for supplying power to motor M (i.e., an electric motor). Adaptive cruise control provided by the system shown in Hongo's Figure 1 relates to power associated with the battery 3. TESLA-1009, 5:17-54, FIG. 1.

[11.b.6] and one or more operational parameters of the vehicle,

159. As described in the '399 patent, examples of "operational parameters" generally include "characteristics that are specific to the vehicle (e.g., characteristics of component parts of the vehicle, including battery, the engine, the powertrain, the tires, etc)." TESLA-1001, 10:25-29 (emphasis added). Elsewhere, the '399 patent describes that "[o]perational parameters may be selected from a group consisting of: aerodynamic parameters (CDA), rolling resistance parameters (Crr1 and Crr2), drive train efficiency parameters, motor efficiency parameters,

and battery model parameters, battery charge and discharge relationships, type of battery.” *Id.*, 4:46-57.

160. In some embodiments of Hongo-Obradovich-Niki, environment information acquisition unit 120 receives “tire information” that is “related to the tires of the vehicle in motion.” TESLA-1005, [0064]. Hongo recognizes that examples of “tire information,” such as “the type of tires installed” and “presence or absence of chains,” is “very useful in calculating the coefficients α and γ ,” which are used for calculating a target speed. *Id.*; *see id.*, [0035]-[0039]. A POSITA would have found it obvious that “tire information” specifying “the type of tires installed” and “presence or absence of chains” includes ***one or more operational parameters of the vehicle*** since Hongo teaches that such information has “a strong influence on braking force, cornering power, etc.” *Id.*, [0064]. For example, a POSITA would have recognized that the type of tires installed on a vehicle (e.g., tire size, rolling circumference) affects how vehicle speed is calculated, and the adaptive cruise control functionality provided by Hongo-Obradovich-Niki would have relied upon information relating to the tire type for appropriate calibration to ensure accurate calculation of speed measurements. *Id.* The examples of tire information described in Hongo are also examples of “characteristics of component parts of the vehicle,” such as “tires,” as described in the ’399 patent as examples of ***operational parameters***. TESLA-1001, 10:25-29.

[11.c.1] *with the power management system set to calculate electric power and speed over a segment of a vehicle route and*

161. As discussed for [1.c], in the data flow depicted in FIG. 2, means 140 and unit 110 operate in conjunction to calculate a “target speed” (“calculate...speed”). A POSITA would have found it obvious that applying the target speed to adjust cruise control involves “calculat[ing] power.” Controlling vehicle’s movement using a target speed through cruise control involves calculating and applying a corresponding power to the vehicle engine because it was well-known that speed and power output of a vehicle are directly correlated such that adjustments to one parameter involves adjustments to the other. TESLA-1018, 157, 167-68. Since adaptive cruise control in Hongo-Obradovich-Niki would have enabled controlling an electric motor of a hybrid vehicle, use of the calculated target vehicle speed in providing adaptive cruise control would have similarly involved applying a “calculated electric power.”

(iv) *Claims 12, 15, 16*

162. Hongo-Obradovich-Niki makes these claims obvious for the same reasons discussed above in the corresponding claim addressed in Section VI.A(ii).

Claim Limitation	Corresponding Claim Limitation
[12]	[2]
[15]	[5]
[16.1], [16.2]	[6.1], [6.2]

(v) *Claim 19*

[19] *The apparatus of claim 11, wherein calculated speed is based at least in part on a determined probable optimal speed using historical route information*

163. Under plain meaning, probable optimal speed is a vehicle speed (speed) that is determined using historical route information and is most likely (probable) to be optimized (optimal) relative to a parameter. This is consistent with the '399 patent, which describes one example of a “probable optimal speed” as being “the most efficient speed (e.g., the speed having the lowest energy requirement) used by the vehicle when traversing the segment.” TESLA-1001, 18:57-67. In Hongo, adaptive cruise control functionality is used to “automatically output[] an optimized or optimized target vehicle speed according to weather, sunlight conditions, etc.” TESLA-1005, [0007] (emphasis added). The target vehicle speed is calculated based on information stored in driving history DB 10 and driving block DB 20. TESLA-1005, [0029], [0044], [0045], FIG. 3. Hongo's target vehicle speed is a speed that is determined using information stored in driving history DB 10 and driving block DB 20 (historical route information) and is most likely (probable) to be optimized (optimal) relative to one or more parameters, e.g., weather, sunlight conditions.

(vi) *Claim 20*

[20] *The apparatus of claim 11, wherein target speed is presented as a range of target speeds.*

164. A POSITA would have found it obvious that certain implementations of the adaptive cruise control system provided by Hongo-Obradovich-Niki are configured to enable cruise control functionality only when a vehicle is traveling over a minimum speed. This is because use of minimum speeds were well-known techniques for enabling the types of cruise control disclosed in Hongo. *See, e.g.*, TESLA-1021, 3:64-4:16 (describing a “adaptive cruise control (ACC) mode” with a “lower speed limit,” “e.g., 35 km/h”); TESLA-1013, 1:30-33 (“ACC systems...can only be activated above a certain minimum speed of 30 km/h”). The use of minimum speeds also ensures adaptive cruise control is used when a vehicle is traveling on highways and open roads, where maintaining a consistent cruising speed is practical and safe.

165. With implementations of Hongo-Obradovich-Niki that use a minimum speed for adaptive cruise control, a POSITA would have understood that a user may attempt to turn on cruise control in scenarios where a current travelling speed of a vehicle is below the minimum speed. In such scenarios, a POSITA would have found it obvious to configure the vehicle to notify the user that cruise control functionality cannot be used since it was well-known by the Critical Date to use monitored vehicle speed information to “control the speed of the automobile

as part of a cruise control operation” and to further “provide the motor vehicle operator with warnings...” TESLA-1022, Abstract. Further, such a configuration would have improved vehicle safety since cruise control can be dangerous when a vehicle cannot be driven safely at a steady speed (e.g., while traveling along a route with frequent traffic stops). To improve vehicle safety, a POSITA would have configured elements in Hongo-Obradovich-Niki, such as Obradovich’s display interfaces 102, to provide warnings relating to cruise control availability based on a current traveling speed and a minimum speed. This configuration is consistent with Obradovich, which teaches that display interfaces 102 provide “information about the vehicle” that is “readily available literally at the fingertips of the user,” such as “operational instructions, maintenance procedures, safety measures...” TESLA-1005, 4:66-5:15. Because Obradovich leaves open the possibility to leverage display interfaces 102 to display “information about virtually every capability of the automobile,” a POSITA would have found it obvious to configure display interfaces 102 to provide a user with information regarding a minimum speed required to enable cruise control functionality.

166. Presentation of warnings relating to a minimum speed by the implementations of Hongo-Obradovich-Niki discussed above make claim 20 obvious. Specifically, warnings *present[]* information relating a target vehicle speed used for adaptive cruise control (*target speed*) based on whether a value of a

current traveling speed (and used to specify the target vehicle speed) is within a range defined by the minimum speed (*range of target speeds*).

167. Specifically, the use of the minimum speed is based on maintaining vehicle safety, so a POSITA would have found it obvious that values of target vehicle speeds applied by adaptive cruise control are above the minimum speed value. For example, when a driver attempts to engage cruise control while traveling at a 25 km/h (below the minimum speed of 35 km), a display in a vehicle may present a warning with the notification “cruise control is only available at speeds greater than 35 km/h.” In this example, presentation of the warning would have informed the driver of the constraints under which cruise control is available, and without such a warning, the driver would have no knowledge of speed limit constraints on cruise control functionality, and may instead think that cruise control is simply broken on the vehicle. Presentation, by implementations of Hongo-Obradovich-Niki, of a range of speeds defined by the minimum value corresponds to presentation of *target speed as a range of target speeds*. TESLA-1022, Abstract.

**B. [GROUND 2] – HONGO, OBRADOVICH, NIKI, AND KUDO
MAKES CLAIMS 3, 4, 13, AND 14 OBVIOUS**

1. Combination of Hongo, Obradovich, Niki, and Kudo

168. As discussed in Section VI.A.1, a POSITA would have been motivated to combine Hongo and Obradovich given the distinct advantages

provided by each reference to vehicle operation. Such advantages include adaptive cruise control functionality provided by Hongo's device 100, and user-friendly vehicle control and operation provided by Obradovich's system 100. A POSITA would have found it predictable that a vehicle incorporating Hongo-Obradovich-Niki would have included adaptive cruise control capabilities (per Hongo) and navigation capabilities (per Obradovich). For example, Obradovich's system 100 includes various types of vehicle interfaces, including a navigation interface 106d (TESLA-1008, 6:63-7:7) and a cruise control interface (*id.* at 8:15-18).

169. In implementing Hongo-Obradovich-Niki, a POSITA would have been motivated to further improve well-known vehicle capabilities given Obradovich's broad objective to "design an information and control system for use inside an automobile with the user in mind." TESLA-1008, 3:21-30. One example discussed in Obradovich is navigation. *See id.*, 1:39-67 (discussing prior art vehicle navigation systems). A POSITA would have been motivated to improve a user's access to information during vehicle navigation to allow Hongo-Obradovich-Niki be more "intuitive and direct so that the user can obtain the relevant information in a few self-explanatory steps." *Id.*, 3:32-63.

170. Like Obradovich, a POSITA would have perceived Kudo to be similarly concerned with improving a user's overall access to information. Kudo recognized "[i]t is much arduous for users to input [information] by themselves,"

and in particular, that “setting a car navigation system on the move by means of an automobile are taxing and may be dangerous operation under certain circumstances.” TESLA-1010, [0002]. From Kudo, a POSITA would have recognized that this is why “many users of car navigation systems drive without setting any destination.” *Id.* A POSITA looking to increase user convenience while driving would have thereby found it advantageous to incorporate Kudo’s destination prediction technique into the navigation system present within Hongo-Obradovich-Niki (e.g., Obradovich’s navigation interface 106d).

171. As discussed in Section V.D, Kudo’s destination prediction technique involves “accumulating, as a travel history, a travel route obtained from the history of position information of the mobile body,” e.g., the vehicle. *Id.*, [0013]. This travel history is used to “predict[] one or more travel destinations where the mobile body will advance,” taking into account factors such as “time, date, weather, driver, a fellow passenger, and the like.” *Id.*, [0013]-[0014]. As combined, Hongo-Obradovich-Niki-Kudo would have used Kudo’s travel history information by, for example, leveraging the same or similar data to that stored in Hongo’s “driving history DB 10” and “driving block DB 20,” to predict a destination of a vehicle (as taught in Kudo).

172. A POSITA would have been motivated to combine the teachings of Hongo-Obradovich-Niki and Kudo since the combination involves use of known

techniques to improve similar devices in the same way. Kudo's technique to predict a destination was a known vehicle navigation technique, which would have improved the control/operation capabilities of a vehicle incorporating Hongo-Obradovich-Niki in the same way as disclosed in Kudo. TESLA-1010, [0013], [0014].

173. A POSITA would have expected success in implementing Hongo-Obradovich-Niki-Kudo. As discussed above, the implementation involves incorporating well-known techniques and elements (e.g., Kudo's *destination prediction technique*) with well-known systems (e.g., a hybrid vehicle incorporating componentry enabling Hongo's adaptive cruise control system and Obradovich's information and control system) without invention.

2. Analysis

(i) Claims 3, 4

[3] *The method of claim 1, further comprising the step of selecting a destination using historical data associated with a driver.*

174. Hongo-Obradovich-Niki-Kudo would have included Kudo's "prediction section 108," which "performs prediction of a future travel destination" using information collected by Kudo's car navigation system. TESLA-1010, [0079]; *see id.* at [0001] ("the present invention relates to a technology for predicting a travel destination from the travel history while storing users' travel

history...”); [0104]. Prediction of a travel destination in Hongo-Obradovich-Niki-Kudo involves *selecting a destination*.

175. The “travel history” is stored in “a history accumulation database (DB) [104] that accumulates a travel route obtained from a history of the position information of the automobile as a travel history.” TESLA-1010, [0078]. An example of travel history information stored in the history accumulation DB 104 is shown in FIG. 3:

FIG.3

104		(a)		(b)	
node number	time	node number	time	node number	time
L6	8:05 a.m. on July 31	L128	12:25 p.m. on July 31	L6	8:05 a.m. on July 31
C8	8:06 a.m. on July 31	C140	12:29 p.m. on July 31	C8	8:06 a.m. on July 31
C12	8:08 a.m. on July 31	C125	12:36 p.m. on July 31	C20	8:08 a.m. on July 31
C9	8:09 a.m. on July 31	.	.	L12	8:10 a.m. on July 31
C34	8:11 a.m. on July 31	.	.	L12	1:40 p.m. on July 31
.	.	L68	1:33 p.m. on July 31	C34	1:50 p.m. on July 31
.	.			.	.
L128	8:53 a.m. on July 31			L6	9:20 p.m. on July 31

TESLA-1010, FIG. 3

In Hongo-Obradovich-Niki-Kudo, prediction section 108 predicts a destination based on travel history information (*historical data associated with a driver*).

176. Moreover, techniques for automatically determining a destination for a vehicle through use of a navigation were conventional by the Critical Date. For example, Kuroda teaches a process during which “the destination is set by the

navigation system 34” using an “optimum route to the destination,” which is retrieved by a “route retrieving unit 34a of the navigation system 34.” TESLA-1010, 6:46-58. Additionally, “even when the occupant does not set the destination, the destination and the route to the destination can be automatically set.” *Id.*

177. Kuroda also offers an example of an “optimum route” as “a frequently used route such as a commuting road on which the vehicle repeatedly drives...” TESLA-1010, 6:46-58. As another example, “[w]hen the vehicle drives at almost the same time as the recorded time on the recorded route, the designation is estimated from the recorded route.” *Id.* In these examples, the destination is identified based on a user’s prior driver activity (*historical data associated with a driver*).

[4] *The method of claim 1, further comprising the step of selecting a destination using statistical destination logic.*

178. *See* [3] (discussing how prediction section 108 in Hongo-Obradovich-Niki-Kudo would have predicted a future travel destination and thereby “*select[s] a destination*”).

179. The ’399 patent describes an example of “[s]tatistical destination logic” as “infer[ing] one or more likely destinations based on the information inputs[,] e.g., “based on the current location and the direction of the vehicle, and the date and time of day.” TESLA-1001, 20:54-67. A POSITA would have

understood and/or found obvious that *statistical destination logic* recited in [4] encompasses logic configured to use a statistical technique to infer a destination.

180. Kudo's prediction section 108 predicts a future travel destination by selecting a "future transition destination node," which, in some examples, is "the node having the highest prediction probability..." TESLA-1010, [0104]. Other prediction techniques include "a method in which a range is provided to each node according to the value of the prediction provability and a node having a range to which a random number value belongs is selected, a method of selecting all nodes having probability values exceeding a predetermined value, and a method of selecting a given number of nodes in order from the node having the highest probability value." *Id.* Because prediction section 108 uses probabilities in selecting a "future transition destination node," a POSITA would have understood that prediction section 108 in Hongo-Obradovich-Niki-Kudo includes logic configured to use a statistical technique to infer a location (*statistical destination logic*). Indeed, Hongo describes embodiments in which its device 100 stores "the variance of n pieces of vehicle speed data," and uses this information "when performing various well-known statistical operations such as evaluating the reliability of vehicle speed data." TESLA-1005, [0031].

(ii) *Claims 13, 14*

181. Hongo-Obradovich-Niki-Kudo makes these claims obvious for the same reasons discussed above in the corresponding claim addressed in Section VI.B.2(i).

Claim Limitation	Corresponding Claim Limitation
[13]	[3]
[14]	[4]

C. [GROUND 3] – HONGO, OBRADOVICH, NIKI, AND KURODA MAKES CLAIMS 7 AND 17 OBVIOUS

1. Combination of Hongo, Obradovich, Niki, and Kuroda

182. As discussed in Section V.A, Hongo describes embodiments in which coefficients used to calculate a target vehicle speed V_0 are based on several types of information, including information received by a “radio” of the vehicle. TESLA-1005, [0064]. The received information “relates to road conditions,” such as “traffic jams, traffic regulations, etc. during driving.” *Id.* Hongo teaches this information is “very useful” when determining “coefficients α , β , γ ” used in calculating the target vehicle speed V_0 but otherwise lacks specific implementation details regarding the “radio.” A POSITA seeking to implement Hongo’s technique of leveraging traffic information to adapt cruise control would have therefore looked to examples of conventional radios used in vehicles to obtain similar types of traffic information.

183. For example, in Kuroda, a vehicle includes a “vehicle roadside communication device” (or “VICS”) for “receiving traffic information and road information by a beacon receiver, and a road map database.” TESLA-1011, 4:56-67. Hongo likewise teaches the acquisition of information in real time from a “radio, beacon, etc.” TESLA-1005, [0064]. Kuroda further describes a process in which information received by a vehicle sensor includes “traffic jam information provided by a VICS or the like.” *Id.* at 6:59-64; FIG. 6. Based on this disclosure, a POSITA would have found it obvious that one implementation of the “radio” in the vehicle implementing Hongo-Obradovich-Niki-Kuroda is a VICS (as described in Kuroda).

184. A POSITA would have been motivated to combine the teachings of Hongo-Obradovich-Niki and Kuroda in the manner discussed above since the combination involves use of known techniques to improve similar devices in the same way. As discussed above, Kuroda’s technique to communicate with the remote database to obtain traffic information was a known technique, which would have improved the control/operation capabilities of a vehicle incorporating Hongo-Obradovich-Niki in the same way as disclosed in Kuroda. TESLA-1011, 6:59-64; FIG. 6.

185. A POSITA would have expected success in implementing Hongo-Obradovich-Niki-Kuroda. As discussed above, the implementation involves

incorporating well-known techniques and elements (use of Kuroda's VICS to obtain traffic jam information) with well-known systems (a hybrid vehicle incorporating componentry enabling Hongo's adaptive cruise control system and Obradovich's information and control system) without invention.

2. Analysis

(i) Claims 7, 17

[7] ***The method of claim 1, wherein the step of determining information about an external environment of a vehicle further comprises the step of communicating with a remote database.***

186. As discussed for [1.b.1], in the data flow shown in Hongo's FIG. 2, means 140 obtains "road environment real-time information X" (***information about an external environment of a vehicle***), including "road surface temperature." By processing the "road environment real time information X" in calculating the target speed, means 140 ***determine[s]*** the road environment real time information X. TESLA-1005, [0011]. In certain embodiments of Hongo, the calculation of the target speed is also based on information received by a "radio" of the vehicle, including traffic information. *Id.*, [0064]. In such embodiments, the information received by the radio (i.e., traffic information) is also an example of ***information about an external environment of a vehicle*** since the information "relates to road conditions," such as "traffic jams, traffic regulations, etc. during driving." *Id.*

187. As discussed in Section VI.C.1, in Hongo-Obradovich-Niki-Kuroda, a POSITA would have found it obvious to implement the “radio” of Hongo as the VICS described in Kuroda. The VICS enables the vehicle to “receiv[e] traffic information and road information by a beacon receiver, and a road map database.” TESLA-1011, 4:56-67. Hongo-Obradovich-Niki-Kuroda would have led a POSITA to implementations where the determination of “road environment real-time information X” (the step of determining information about an external environment of a vehicle) involves the VICS receiving traffic information (e.g., road condition) while also receiving “road information” based on communications with Kuroda’s “road map database” (communicating with a remote database). A POSITA would have found it obvious that the “road map database” is an example of a remote database (e.g., a database that is remote from a vehicle) because Kuroda describes using the VICS for communications between a vehicle and the “roadmap database” and VICS were known by the Critical Date to permit a vehicle to wirelessly communicate with remote systems. TESLA-1010, 4:56-67; TESLA-1020, 1:16-51, 23:47-4:18.

[17] *The apparatus of claim 11, wherein determining information about an external environment of a vehicle further comprises communicating with a remote database.*

188. See discussion above regarding [7].

**D. [GROUND 4] – HONGO, OBRADOVICH, NIKI, AND
NEWSTROM MAKES CLAIMS 8 AND 18 OBVIOUS**

1. Combination of Hongo, Obradovich, Niki, and Newstrom

189. Hongo recognizes that “weather and sunlight conditions” may “change naturally over time,” which similarly causes dynamic changes in “road surface conditions and driver visibility.” TESLA-1005, [0005]. Hongo further teaches that “it is desirable to change the target vehicle speed from time to time in response to weather,” and a POSITA would have understood that this disclosure is based on Hongo’s concerns for safety in certain weather scenarios. *Id.* Hongo further recognizes use of “a constant vehicle speed that is sufficiently safe for all situations,” but discourages such a configuration since this would be “relatively slow” during good weather conditions, e.g., a “dry road with a good view during the daytime and clear weather...” *Id.*, [0006].

190. As to poor weather conditions, Hongo recognizes “it is possible to estimate the frozen state of the road surface, the snowy state, and the like[,]” but is primarily focused on adapting the target vehicle speed calculation to improve safety. *Id.*, [0013]; *see id.*, [0040]. However, by the Critical Date, a POSITA would have understood that the poor weather conditions described in Hongo (e.g., “snowy state”) presents safety risks to vehicle operation beyond vehicle travel speed. For example, Trach (TESLA-1015) noted that, in the United States, “lane departures are the single most frequent causal factor in fatal crashes.” A POSITA would have

been motivated to seek other techniques to improve safety of vehicle operation when road surface conditions and driver visibility is poor. *Id.*

191. As discussed in Section V.F, Newstrom describes using the lane boundary information in geospatial database 20 to generate “[w]arnings of lane departure” through “use of steering wheel vibrations or oscillations...” TESLA-1012, 7:56-64. Lane departures may be determined using, for example, “the Time to Lane Crossing (TLC) approach,” which is based on “the vehicle’s speed, orientation relative to [a] LaneCenter” or other attributes. *Id.* Newstrom also provides a “virtual rumble strip” that may “generate[] haptic feedback that provides a ‘feel’ of the road to the driver by imposing, for example, a reactive torque as a function of positional change relative to the road geometry.” TESLA-1012, 4:54-5:6.

192. A POSITA would have found it obvious implementing Newstrom’s techniques into a vehicle incorporating Hongo-Obradovich-Niki would have further improved user safety during poor weather conditions in two ways. First, using Newstrom’s TLC approach, a vehicle incorporating Hongo-Obradovich-Niki-Newstrom would have leveraged sensor data collected by Hongo’s onboard vehicle sensors to identify lane departures using lane boundary information stored in Newstrom’s database 20. Second, using Newstrom’s “virtual rumble strip,” a steering wheel of the vehicle incorporating Hongo-Obradovich-Niki-Newstrom

could be leveraged to provide haptic feedback relating to lane departure monitoring.

193. Finally, a POSITA would have also reasonably expected to succeed in combining Hongo, Obradovich, Niki, and Newstrom since the combination would have required only routine knowledge well within the skill of a POSITA prior to the earliest effective filing date. Hongo describes that driving history data 11 may store “lane classifications,” suggesting use of other types of lane information, such as the lane boundary information in Newstrom’s geospatial database 20, would have been within the capabilities of a POSITA without invention. *Id.*; TESLA-1005, [0029]. In this manner, Hongo-Obradovich-Niki-Newstrom would have merely involved combining prior art elements according to known methods to yield predictable results.

194. The elements of Hongo-Obradovich-Niki-Newstrom would each perform functions they had been known to perform prior to the combination—Hongo’s adaptive cruise control technique would have used environmental information to calculate a target vehicle speed, and Newstrom’s TLC approach would have leveraged lane boundary information specified in a geospatial database to identify lane departures and provide responsive haptic feedback to a user.

195. The combination also involves use of known techniques to improve similar devices in the same way. As discussed above, Newstrom’s use of lane

boundary information was a known technique for improving vehicle operation in certain external conditions (e.g., snowy road conditions), and a vehicle incorporating Hongo-Obradovich-Niki was ready for improvement since Hongo describes use of adaptive cruise control in snowy road conditions. TESLA-1005, [0005], [0006]. A POSITA would have perceived the combination to yield predictable results of using lane boundary information to improve navigation when a vehicle is presently traveling along a snowy route. TESLA-1015, 10. A POSITA would have also expected success in implementing Hongo-Obradovich-Niki-Newstrom.

2. Analysis

(i) Claims 8, 18

[8] ***The method of claim 1, wherein the step of determining information about operational status of a vehicle further comprises the step of communicating with a remote database.***

196. As discussed for [1.b.2], in the data flow shown in Hongo's Figure 2, means 140 obtains "current vehicle speed V," which is one example of ***information about operational status of the vehicle***. TESLA-1005, [0028]. In Hongo-Obradovich-Niki-Newstrom, a vehicle is configured to perform lane boundary monitoring, and thus, another example of ***information about operational status of the vehicle*** is lane departure information determined using Newstrom's

“Time to Lane Crossing (TLC) approach” based on “the vehicle’s speed, orientation relative to [a] LaneCenter” or other attributes. TESLA-1012, 7:56-64.

197. As discussed in Section VI.D.1, Hongo-Obradovich-Niki-Newstrom would have improved the safety of vehicle operation during poor weather conditions (e.g., snowy roads) through use of adaptive cruise control (per Hongo) and lane departure monitoring and feedback (per Newstrom). TESLA-1005, [0040]; TESLA-1012, 7:56-64. In performing lane departure monitoring, Hongo-Obradovich-Niki-Newstrom would have determined lane departures “from the vehicle’s speed, position, and orientation” relative to attributes specified in Newstrom’s geospatial database 20 (e.g., LaneBoundary object) (*database*). *Id.*; *see id.*, FIG. 3. Since the process of determining lane departures (*step of determining information about operational status of the vehicle*) involves using attributes specified in geospatial database 20, a POSITA would have understood and/or found obvious that lane boundary monitoring involves communicating with geospatial database 20 (*the step of communicating with a...database*). Further, Newstrom describes that database 20 can be loaded by database manager 22 into “solid state memory” located in a vehicle through a “wireless connection to server,” and thus, geospatial database 20 may be hosted on a server that is remote from a vehicle, and implemented as a *remote database*. TESLA-1012, 8:26-38. Additionally, because the database manager 22 can also “load new portions [of the

database 20]” as a vehicle’s location changes, a POSITA would have understood that the vehicle can use a wireless connection to the server as the vehicle is being driven. *Id.*

[18] *The apparatus of claim 11, wherein determining information about operational status of a vehicle further comprises communicating with a remote database.*

198. See discussion above regarding [8].

VII. LEGAL STANDARDS

A. Terminology

199. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. 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. Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention was made (not today). Because I do not know at what date the invention as claimed was made, I have used the Critical Date as the point in time for claim interpretation purposes.

B. Legal Standards for Anticipation

200. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as anticipated. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art.

201. I am informed by Counsel and understand that a challenged claim is unpatentable as “anticipated” under 35 U.S.C. § 102 if it is determined that all the limitations of the claim are described in a single prior art reference. I am informed by Counsel and understand that, to anticipate a claim, a prior art reference must disclose, either expressly or inherently, each and every limitation of that claim and enable one of ordinary skill in the art to make and use the invention.

202. I have been informed by Counsel and understand that in an inter partes review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of anticipation, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

C. Legal Standards for Obviousness

203. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as obvious. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the

time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

204. I have been informed by Counsel and understand that a claim is unpatentable for obviousness under 35 U.S.C. § 103 “if 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 to which said subject matter pertains.” I am informed by Counsel and understand that obviousness may be based upon a combination of references. I am informed by Counsel and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

205. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the

marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

206. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by counsel for the Patent Owner and understand that identifying a reason those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

207. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) any objective indicia of non-obviousness, such as commercial success, long-felt but unresolved need, failure of others, industry recognition, copying, and unexpected results. I understand that the foregoing factors are sometimes referred to as the "Graham factors."

208. I have been informed by Counsel and understand that an obviousness evaluation can be based on a combination of multiple prior art references. I

understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

209. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

210. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

211. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

212. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

213. I have been informed by Counsel and understand that secondary indicia of non-obviousness may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long felt need; and (8) skepticism by experts. I understand that evidence of secondary indicia of non-obviousness, if available, should be considered as part of the obviousness analysis.

214. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

215. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

216. I have been informed by Counsel and understand that in an inter partes review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of obviousness, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

VIII. CONCLUSION

217. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information introduced throughout this proceeding.

218. I declare under penalty of perjury that the foregoing is true and accurate to the best of my ability.

APPENDIX

Vassilios Morellas

Curriculum Vitae

November 2023

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University of Minnesota, 200 Union Street, SE,
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Education

- 1995 Ph.D. in Mech. Eng. University of Minnesota, Twin Cities.
- 1988 M.Sc. in Mech. Eng. Columbia University, New York, NY.
- 1983 Diploma Mech. Eng. National Technical University of Athens, Greece.

Current & Past Positions

- 2020- **Research Professor**, Electrical & Computer Engineering, U. of Minn., Twin Cities.
- 2014- **Director**, NSF center on Robots & Sensors for Human Well Being, U. of Minn., Twin Cities.
- 2006-2020 **Program Director**, Computer Science & Engineering, U. of Minn., Twin Cities.
- 2007-2014 **Co-PI**, NSF Research Center on Safety, Security and Rescue, U. of Minn., Twin Cities.
- 2003-2014 **Instructor**, Dept. of Mech. Eng., University of Minnesota, Twin Cities.

Industrial and Professional Experience

- 2005-2006 **Sr. Principle Research Scientist**, Adv. Tech. Labs, Honeywell Int., Inc.
- 1998-2005 **Principle Research Scientist**, Adv. Tech. Labs, Honeywell Int., Inc.
- 1995-1998 **Research Associate**, Dept. of Mech.Eng., U. of Minn., Minneapolis, MN.

Legal Experience

- **Finnegan, Henderson, Farabow, Garrett & Dunner, LLP**
August 2022: Pavemetrics vs Tetra Tech
Location: UNITED STATES DISTRICT COURT, CENTRAL DISTRICT OF CALIFORNIA
Role: Expert witness in computer vision, algorithms, and software engineering.
Provided testimony on software development practices and code analysis in a patent infringement case.

Honors and Awards

- Center for Transportation Studies: CTS Research Partnership Award, 2016.
- Best Student Paper Award, IEEE International Conference on Image Processing (ICIP), 2012.
- Technical Achievement Award, for Technical Excellence in the area of **People Tracking in Camera Networks**, *Highest Honorary Distinction* from Automation and Control Solutions (ACS) of Honeywell International Inc., April 2003.
- Technical Achievement Award, for Technical Excellence for development and installation of the **SGATE: Secure Gate Access Technology Evaluation**, *Highest Honorary Distinction* from Automation and Control Solutions (ACS) of Honeywell International Inc., April 2003.
- Technical Achievement Award, for Technical Excellence in the area of **Outdoor Visual Surveillance**, *Highest Honorary Distinction*, Honeywell International Inc., December 2001.
- Second Prize, ITS World Magazine's, GPS Applications Showcase, 1997.

- First Prize, Pan-Hellenic competition on “Heat Pumps” presented by the Rotary Club of Athens, Greece (sponsored by Toshiba), 1984.
- Fellowship from the Greek Ministry of Education for academic excellence during undergraduate studies, 1982.

Research Grants

- *Maintenance for the Truck Parking Availability System of the State of Kansas*
Role: Co-PI.
Sponsors: Kansas DOT.
Performance period: January 1, 2024 – December 31, 2029 - **Total amount:** \$725,000
- *A Real-Time Truck Parking Availability System of the State of Kansas*
Role: Co-PI.
Sponsors: Kansas DOT.
Performance period: October 1, 2016 – December 31, 2019 - **Total amount:** \$1,265,000
- *I/UCRC Phase II: Robots and Sensors for the Human Well-being*
Role: PI.
Sponsors: National Science Foundation (NSF).
Performance period: December 2019 - December 2024 - **Total amount:** \$725,000
- *MRI: Development of an Instrument that Performs Behavioral Analysis for Neurological Disorders like the Tourette Syndrome*
Role: Co-PI.
Sponsors: National Science Foundation (NSF).
Performance period: September 2019 - August 2024 - **Total amount:** \$1,823,000
- *NRI: INT: COLLAB: Robot Teams for Precision Agriculture and Plant Health Management*
Role: Senior personnel
Sponsors: National Science Foundation (NSF).
Performance period: September 2019 - August 2022 - **Total amount:** \$933,000
- *SCH: Active Learning for Medical Applications*
Role: Co-PI.
Sponsors: NIH/NCI.
Performance period: February 1, 2018 – January 31, 2022 - **Total amount:** \$1,320,000
- *CPS: TTP Option: Synergy: Collaborative Research: Dynamic Methods of Traffic Control that Impact Quality of Life in Smart Cities*
Role: Co-PI.
Sponsors: National Science Foundation (NSF).
Performance period: September 15, 2015 – February 29, 2020 - **Total amount:** \$1,248,000
- *Maintenance for the Truck Parking Availability System of the State of Kansas*
Role: Co-PI.
Sponsors: Kansas DOT.
Performance period: January 1, 2019 – December 31, 2023 - **Total amount:** \$649,000
- *A Real-Time Truck Parking Availability System for the State of Wisconsin*
Role: Co-PI.
Sponsors: MN DOT.
Performance period: June 30, 2016 – December 31, 2019 - **Total amount:** \$395,000
- *A Real-Time Truck Parking Availability System of the State of Kansas*
Role: Co-PI.
Sponsors: Kansas DOT.
Performance period: October 1, 2016 – December 31, 2019 - **Total amount:** \$1,265,000

- *I/UCRC Phase I: Robots and Sensors for the Human Well-being*
Role: PI.
Sponsors: National Science Foundation (NSF).
Performance period: September 2014–September 2019.
Total amount: \$854,600
- *MNDRIVE RSAM: Utilizing Computer Vision Technology for Cross-Cultural Developmental Screening in Early Childhood*
Role: Co-PI (with Suma Jacob, MD, PhD Department of Psychiatry, UMN).
Sponsors: University of Minnesota (MnDRIVE).
Performance period: September 2014.
Total amount: \$50,000
- *MRI: Development of an Instrument that Monitors Behaviors Associated with OCD and Schizophrenia*
Role: Co-PI (with prof. N. Papanikolopoulos, G. Bernstein, U of Minnesota).
Sponsors: National Science Foundation (NSF).
Performance period: November 2013–September 2017.
Total amount: \$560,000
- *A Comprehensive System for Assessing Truck Parking Availability*
Role: Co-PI (with N. Papanikolopoulos, U of Minnesota).
Sponsors: FHWA and MN DOT.
Performance period: January 11, 2012 – November 30, 2016.
Total amount: \$2,267,711
- *MRI: Development of a Video-Based Robotic Instrument for Behavioral Analysis and Diagnosis of at Risk Children*
Role: Co-PI (with N. Papanikolopoulos, K. Lim (U of Minnesota) and G. Sapiro (Duke University)).
Sponsors: National Science Foundation (NSF).
Performance period: October 1, 2010 – September 30, 2019.
Total amount: \$1,725,730
- *CDI-II: Computational Tools for Behavioral Analysis Diagnosis and Intervention of at Risk Children*
Role: Co-PI (with N. Papanikolopoulos, K. Lim (U of Minnesota) and G. Sapiro (Duke University)).
Sponsors: National Science Foundation (NSF).
Performance period: September 2010–September 2015.
Total amount: \$1,578,897
- *ComputerAided Cancer Diagnosis in Surgical Pathology*
Role: Co-PI, with N. Papanikolopoulos, et al.
Sponsors: Institute for Engineering in Medicine (IEM) Seed Grant
Performance period: January 2012–December 31, 2012.
Total amount: \$39,508.
- *I/UCRC: Collaborative Research:*
Detecting Cancer Using Advanced Computer Vision Techniques
Role: Co-PI (with N. Papanikolopoulos, A. Banerjee, U of Minnesota).
Sponsors: NSF.
Performance period: August 2009–July 2013.
Total amount: \$99,998
- *Collaborative Research: I/UCRC for Safety, Security, and Rescue Research*
Role: Co-PI (with N. Papanikolopoulos, U of Minnesota).
Sponsors: National Science Foundation (NSF).
Performance period: August 2009–July 2013.

Total amount: \$330,000

- *Video Detection and Classification of Pedestrian Events at Roundabouts and Crosswalks*
Role: PI (with T. Morris and J. Hourdos, U of Minnesota).
Sponsors: Intelligent Transportation Systems (ITS) Institute (RITA).
Performance period: September 2011–June 2013.
Total amount: \$75,000
- *I/UCRC Basic Research Grant: A New Miniature Ground/Water Robot*
Role: Co-PI (with prof. N. Papanikolopoulos, U of Minnesota).
Sponsors: National Science Foundation (NSF).
Performance period: August 2009–July 2013.
Total amount: \$128,000
- *Sensing for HOV/HOT Lanes Enforcement*
Role: Co-PI (with prof. N. Papanikolopoulos, U of Minnesota).
Sponsors: Minnesota Dept of Transportation (MnDoT).
Performance period: July 2013–October 2013.
Total amount: \$97,200
- *Mass Transit Surveillance and Early Warning System*
Role: Principal Co-Investigator (with prof. N. Papanikolopoulos, U of Minnesota).
Sponsors: U. S. Department of Homeland Security.
Performance period: August 2004–September 2011.
Total amount: \$4.5 M
- *Appearance Models for Tracking across Multiple Cameras*
Role: Program Manager and Principal Co-Investigator (joint with prof. Larry Davis and Rama Chellappa, U of Maryland).
Sponsors: HSARPA (Homeland Security ARPA)/COTR ONR.
Performance period: May 2005–May 2007.
Total amount: \$1.3 M
- *Secure Gate Access Technology Evaluation (SGATE)*
Role: Principal Investigator.
Sponsors: Jointly sponsored by ONR and Honeywell Laboratories.
Performance Period: June 2002 – June 2003.
Total amount: \$900 K.
- *Detection of Events for Threat Evaluation and Recognition (DETER)*
Role: Principal Co-Investigator (joint with prof. I. Pavlidis of U of Houston).
Sponsors: Honeywell Laboratories.
Performance Period: June 1999–August 2002.
Total amount: \$700 K.
- *Digital Integration of Video for Airport Security (DIVAS)*
Role: Principal Investigator.
Sponsors: Honeywell Laboratories and Federal Aviation Administration (FAA).
Performance Period: June 1999–August 2004.
Total amount: \$1.2 M

Books

1. I. Pavlidis, V. Morellas and P. Roeber. *Programming cameras and pan-tilts with DirectX and Java*, Morgan Kaufmann Publishers Inc., 2003.

Book Chapters

1. I. Pavlidis and V. Morellas. *Two examples of indoor and outdoor surveillance systems*, In Video-based Surveillance Systems: Computer Vision and Distributed Processing, Kluwer Academic Publishers, Boston, pp. 39–51, 2002.

Refereed Journal Publications

1. L. Guzman, V. Morellas and N. Papanikolopoulos, *Robotic Embodiment of Human-Like Motor Skills via Reinforcement Learning*, in IEEE Robotics and Automation Letters, vol. 7, no. 2, pp. 3711–3717, April 2022, doi: 10.1109/LRA.2022.3147453.
2. A. Cherian, P. Stanitsas, J. Wang, M. Harandi, V. Morellas, and N. Papanikolopoulos. *Learning Log-Determinant Divergences for Positive Definite Matrices*, IEEE Pattern Analysis and Machine Intelligence, (PAMI), 2021.
3. P. Stanitsas, A. Cherian, V. Morellas, R. Tejapaul, N. Papanikolopoulos and A. Truskinovsky. *Image Descriptors for Weakly Annotated Histopathological Breast Cancer Data*, Frontiers in Digital Health, 2020.
4. D. Zermas, V. Morellas, D. Mulla, and N. Papanikolopoulos. *3D Model processing for high-throughput phenotype extraction - The case of corn*, Journal of Computers and Electronics in Agriculture, 2020.
5. N. Walczak, J. Fasching, K. Cullen, V. Morellas, and N. Papanikolopoulos. *Toward Identifying Behavioral Risk Markers for Mental Health Disorders: An Assistive System for Monitoring Children's Movements in a Preschool Classroom*, Machine Vision and Applications, 29(3), pp 703–717, 2018.
6. G. Bernstein, T. Hadjiyanni, K. Cullen, M. Robinson, E. Harris, A. Young, J. Fasching, N. Walczak, S. Lee, V. Morellas, and N. Papanikolopoulos. *Use of Computer Vision Tools to Identify Behavioral Markers of Pediatric Obsessive-Compulsive Disorder: A Pilot Study*, J Child Adolesc Psychopharmacol.; 27(2):140-147. doi: 10.1089/cap.2016.0067. Epub 2016 Nov 10., 2017.
7. E. Harris, G. Bernstein, K. Cullen, S. Lee, T. Hadjiyanni, J. Robinson, A. Young, V. Morellas, and N. Papanikolopoulos. *1.64 Exploring Visual Design preferences in Youths with Obsessive-Compulsive Disorder*, In Journal of the American Academy of Child and Adolescent Psychiatry, 55(10) 2016.
8. A. Cherian, V. Morellas, and N. Papanikolopoulos. *Bayesian non-parametric clustering of positive definite tensors*, In IEEE Transactions on Pattern Analysis and Machine Intelligence, 38(5), pp.862-874, 2015.
9. R. Sivalingam, D. Boley, V. Morellas, and N. Papanikolopoulos. *Tensor Dictionary Learning for Positive Definite Matrices*, In IEEE transactions on Image Processing, 24(11), pp.4592–4601 2016.
10. G. Somasundaram, A. Cherian, V. Morellas and N. Papanikolopoulos. *Action recognition using global spatio-temporal features derived from sparse representations*, Computer Vision and Image Understanding, 123: pp.1–13, 2014.
11. A. Cherian, S. Sra V. Morellas, and N. Papanikolopoulos. *Efficient nearest neighbors via robust sparse hashing*, In Transactions on Image Processing, Volume:23, Issue:8, pp.3646–3655, 2014.
12. J. Hashemi, T. V. Spina, M. Tepper, A. Esler, V. Morellas, N. Papanikolopoulos, H. Egger, G. Dawson and G. Sapiro. *Computer vision tools for low-cost and non-invasive measurement of autism-related behaviors in infants*, Autism Research and Treatment, Volume 2014, <http://dx.doi.org/10.1155/2014/935686>, 2014.
13. R. Sivalingam, D. Boley, V. Morellas and N. Papanikolopoulos. *Tensor sparse coding for positive definite matrices*, In IEEE Transactions on Pattern Analysis and Machine Intelligence, 36(3): pp.592–605, 2014.

14. G. Somasundaram, R. Sivalingam, V. Morellas and N. Papanikolopoulos. *Classification and counting of composite objects in traffic scenes using global and local image analysis*, In IEEE Transactions on Intelligent Transportation Systems (ITS), Volume:14, Issue:1, pp.69–81, 2013.
15. K. A. Patwardhan, G. Sapiro and V. Morellas. *Robust foreground detection in video using pixel layers*, In IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume 30, pp. 746–751, 2008.
16. V. Morellas, I. Pavlidis and P. Tsiamyrtzis. *Deter: detection of events for threat evaluation and recognition*, In Machine Vision and Applications, Springer-Verlag, volume 15, pp. 29–45, 2003.
17. I. Pavlidis, V. Morellas, P. Tsiamyrtzis and S. Harp. *Urban surveillance systems: from the laboratory to the commercial world*, In Proceedings of the IEEE, volume 89, pp. 1478–1497, 2001.
18. I. Pavlidis, V. Morellas and N. Papanikolopoulos. *A vehicle occupant counting system based on near-infrared phenomenology and fuzzy neural classification*, In IEEE Transactions on Intelligent Transportation Systems, Volume 1, pp. 72–85, 2000.
19. C. Nevruineanu, V. Morellas and M. Donath. *Automated process planning: reasoning from first principles based on geometric relation constraints*, In Artificial Intelligence for Engineering, Design, Analysis and Manufacturing, Cambridge Univ Press, volume 7, pp. 159–179, 1993.
20. N. Zabaras, V. Morellas and D. Schnur. *Spatially regularized solution of inverse elasticity problems using the BEM*, In Communications in applied numerical methods, Wiley Online Library, Volume 5, pp. 547–553, 1989.

Referred Conference Publications

1. D. Zermas, V. Morellas, D. Mulla, and N. Papanikolopoulos. *Extracting Phenotypic Characteristics of Corn Crops Through the Use of Reconstructed 3D Models*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2018.
2. P. Stanitsas, A. Cherian, M. Harandi, V. Morellas, and N. Papanikolopoulos. *Learning Discriminative Alpha-Beta Divergences for Positive Definite Matrices*, In IEEE International Conference of Computer Vision (ICCV), 2017.
3. P. Stanitsas, A. Cherian, V. Morellas, and N. Papanikolopoulos. *Clustering Positive Definite Matrices by Learning Information Divergences*, In Workshop on Manifold Learning: from Euclid to Riemann (ICCV), 2017.
4. P. Stanitsas, A. Cherian, A. Truskinovsky, V. Morellas, and N. Papanikolopoulos. *Active Convolutional Neural Networks for Cancerous Tissue Recognition*, In IEEE International Conference on Image Processing (ICIP), 2017.
5. N. Heller, P. Stanitsas, V. Morellas, and N. Papanikolopoulos. *A Web-Based Platform for Distributed Annotation of Computerized Tomography Scans*, 6th Joint International Workshops, CVII-STENT 2017 and 2nd International Workshop, LABELS 2017 Held in Conjunction with MICCAI 2017, Proceedings. Springer Verlag, Vol. 10552 LNCS, p. 136-145 10 p. (Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics); vol. 10552 LNCS), 2017.
6. D. Zermas, V. Morellas, D. Mulla, and N. Papanikolopoulos. *Estimating the Leaf Area Index of crops through the evaluation of 3D models*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 6155-6162, 2017.
7. P. Stanitsas, A. Cherian, X. Li, A. Truskinowski, V. Morellas, and N. Papanikolopoulos. *Evaluation of feature descriptors for cancerous tissue recognition*, In IEEE 3rd International Conference on Pattern Recognition, ICPR, pp. 1490-1495, 2016.

8. P. Stanitsas, A. Cherian, V. Morellas, and N. Papanikolopoulos. *Active Constrained Clustering via non-iterative uncertainty sampling*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp.4027-4033, 2016.
9. J. Fasching, N. Walczak, G. Bernstein, T. Hadjiyanni, K. Cullen, V. Morellas, and N. Papanikolopoulos. *Automated coding of activity videos from an OCD study*, In IEEE International Conference on Robotics and Automation (ICRA'16), pp. 5638-5643, 2016.
10. J. Fasching, N. Walczak, T. Hadjiyanni, G. Bernstein, K. Cullen, M. Mikkelsen, N. Studanski, V. Morellas, and N. Papanikolopoulos. *Exploring video descriptions for handwashing activities as part of an obsessive-compulsive disorder study*, In IEEE 24th Mediterranean Conference on Control and Automation, pp.1174-1179, 2016.
11. D. Zermas, D. Teng, P. Stanitsas, M. Bazakos, D. Kaiser, V. Morellas, D. Mulla, and N. Papanikolopoulos. *Automation solutions for the evaluation of plant health in corn fields*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp.6521-6527, 2015.
12. J. Fasching, N. Walczak, V. Morellas, and N. Papanikolopoulos. *Classification of motor stereotypes in video*, In IEEE International Conference on Robotics and Automation (ICRA'15), 2015.
13. D. Zermas, M. Bazakos, V. Morellas, D. Mulla, and N. Papanikolopoulos. *A Robotics framework for the detection of nitrogen deficiencies in corn fields*, In IEEE International Conference on Robotics and Automation (ICRA'15), 2015.
14. D. J. Cook, T. Morris, V. Morellas, and N. Papanikolopoulos. *An automated system for persistent real-time truck parking detection and information dissemination*, In IEEE International Conference on Robotics and Automation (ICRA'14), pp.3989–3994, 2014.
15. J. Duncs, R. Sivalingam, G. Somasundaram, V. Morellas, and N. Papanikolopoulos. *Recognition of ballet micro-movements for use in choreography*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp.1010–1016, 2013.
16. J. Hashemi, T. V. Spina, M. Tepper, A. Esler, V. Morellas, N. Papanikolopoulos and G. Sapiro. *A computer vision approach for the assessment of autism-related behavioral markers*, In IEEE International Conference on Development and Learning and Epigenetic Robotics (ICDL), pp. 1–7, 2012.
17. G. Somasundaram, V. Morellas and N. Papanikolopoulos. *Object classification with efficient global self-similarity descriptors based on sparse representations*, In 19th IEEE International Conference on Image Processing (ICIP), pp. 2165–2168, 2012.
18. J. Fasching, N. Walczak, R. Sivalingam, K. Cullen, B. Murphy, G. Sapiro, V. Morellas and N. Papanikolopoulos. *Detecting risk-markers in children in a preschool classroom*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp.1010–1016, 2012.
19. N. Walczak, J. Fasching, W. D. Toczyski, R. Sivalingam, N. D. Bird, K. Cullen, V. Morellas, B. Murphy, G. Sapiro and N. Papanikolopoulos. *A nonintrusive system for behavioral analysis of children using multiple RGB+depth sensors*, In IEEE Workshop on the Applications of Computer Vision (WACV), pp. 217–222, 2012.
20. R. Sivalingam, G. Somasundaram, V. Bhatawadekar, V. Morellas and N. Papanikolopoulos. *Sparse representation of point trajectories for action classification*, In IEEE International Conference on Robotics and Automation (ICRA), pp. 3601–3606, 2012.
21. R. Sivalingam, A. Cherian, J. Fasching, N. Walczak, N. Bird, V. Morellas, B. Murphy, K. Cullen, K. Lim, G. Sapiro, and N. Papanikolopoulos. *A multi-sensor visual tracking system for behavior monitoring of at-risk children*, In IEEE International Conference on Robotics and Automation (ICRA), pp. 1345–1350, 2012.

22. D. Fehr, A. Cherian, R. Sivalingam, S. Nickolay, V. Morellas and N. Papanikolopoulos. *Compact covariance descriptors in 3d point clouds for object recognition*, In IEEE International Conference on Robotics and Automation (ICRA), pp. 1793–1798, 2012.
23. J. Fasching, N. Walczak, R. Sivalingam, K. Cullen, B. Murphy, G. Sapiro, V. Morellas, N. Papanikolopoulos. *Detecting risk-markers in children in a preschool classroom*, In IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 1010–1016, 2012.
24. A. Cherian, V. Morellas and N. Papanikolopoulos. *Robust Sparse Hashing*, In 19th IEEE International Conference on Image Processing (ICIP), pp. 2417–2420, 2012. (**Best Student Paper Award**)
25. R. Sivalingam, D. Boley, V. Morellas and N. Papanikolopoulos. *Positive definite dictionary learning for region covariances*, In IEEE International Conference on Computer Vision (ICCV), pp. 1013–1019, 2011.
26. R. Sivalingam, A. D’Souza, M. Bazakos, R. Mieziako, V. Morellas and N. Papanikolopoulos. *Dictionary learning for robust background modeling*, In IEEE International Conference on Robotics and Automation (ICRA), pp. 4234–4239, 2011.
27. H. J. Min, N. Papanikolopoulos, C. E. Smith and V. Morellas. *Feature-based covariance matching for a moving target in multi-robot following*, In 19-th Mediterranean Conference on Control & Automation (MED), pp. 163–168, 2011.
28. P. K. Gali, V. Morellas and N. Papanikolopoulos. *A novel framework for annotating videos using text*, In 19th Mediterranean Conference on Control Automation (MED), pp. 1403–1408, 2011.
29. A. Cherian, V. Morellas, N. Papanikolopoulos and S. J. Bedros. *Dirichlet process mixture models on symmetric positive definite matrices for appearance clustering in video surveillance applications*, In IEEE Conference on Computer Vision and Pattern Recognition (CVPR), pp. 3417–3424, 2011.
30. A. Cherian, V. Morellas and N. Papanikolopoulos. *Approximate nearest neighbors via dictionary learning*, In Proc. SPIE 8058, Independent Component Analyses, Wavelets, Neural Networks, Biosystems, and Nanoengineering IX, 80581M; doi:10.1117/12.887484, 2011.
31. V. Bhatawadekar, D. Fehr, V. Morellas and N. Papanikolopoulos. *A dynamic sensor placement algorithm for dense sampling*, In Proceedings of the 14th International Conference on Information Fusion (FUSION), pp. 1–7, 2011.
32. R. Sivalingam, G. Somasundaram, V. Morellas, N. Papanikolopoulos, O. Lotfallah, Y. Park. *Dictionary learning based object detection and counting in traffic scenes*, In Proceedings of the Fourth ACM/IEEE International Conference on Distributed Smart Cameras, pp. 42–48, 2010.
33. E. Ribnick, V. Morellas and N. Papanikolopoulos. *Human motion patterns from single camera cues for medical applications*, In IEEE International Conference on Robotics and Automation (ICRA), pp. 5102–5107, 2010.
34. A. Cherian, J. Andersh, V. Morellas, B. Mettler and N. Papanikolopoulos. *Motion estimation of a miniature helicopter using a single onboard camera*, In American Control Conference (ACC), 2010, pp. 4456–4461, 2010.
35. G. Somasundaram, V. Morellas and N. Papanikolopoulos. *Counting pedestrians and bicycles in traffic scenes*, In 12th International IEEE Conference on Intelligent Transportation Systems (ITSC’09), pp. 1–6, 2009.
36. R. Sivalingam, V. Morellas, D. Boley and N. Papanikolopoulos. *Metric learning for semi-supervised clustering of region covariance descriptors*, In Third ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC), pp. 1–8, 2009.

37. D. Fehr, R. Sivalingam, V. Morellas, N. Papanikolopoulos, O. Lotfallah and Y. Park. *Counting people in groups* , In Sixth IEEE International Conference on Advanced Video and Signal Based Surveillance AVSS'09, pp. 152–157, 2009.
38. A. Cherian, J. Andersh, V. Morellas, N. Papanikolopoulos and B. Mettler. *Autonomous altitude estimation of a UAV using a single onboard camera* , In IEEE/RSJ International Conference on Intelligent Robots and Systems, pp. 3900–3905, 2009.
39. A. Cherian, V. Morellas and N. Papanikolopoulos. *Accurate 3D ground plane estimation from a single image* In IEEE International Conference on Robotics and Automation, pp. 2243–2249, 2009.
40. V. Morellas, C. Johnston, A. Johnson, S. D. Roberts, G. L. Francisco. *Day, night and all-weather security surveillance automation*, In Proceedings of SPIE, volume 5778, Sensors, and Command, Control, Communications, and Intelligence (C3I) Technologies for Homeland Security and Homeland Defense IV, 757, 2005.
41. B. Schiller, V. Morellas and M. Donath. *Collision avoidance for highway vehicles using the virtual bumper controller*, In Proceedings of the IEEE International Symposium on Intelligent Vehicles, 1998.
42. V. Morellas, T. Morris, L. Alexander and M. Donath. *Preview based control of a tractor trailer using DGPS for preventing road departure accidents*, In IEEE Conference on Intelligent Transportation Systems, pp. 797–805, 1997.
43. V. Morellas, J. Minners and M. Donath. *Implementation of real time spatial mapping in robotic systems through self-organizing neural networks*, In Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems, volume 1, pp. 277–284, 1995.
44. S. Kieffer, V. Morellas and M. Donath. *Neural network learning of the inverse kinematic relationships for a robot arm*, In Proceedings of IEEE International Conference on Robotics and Automation, pp. 2418–2425, 1991.

Workshop and Other Publications

1. N. Heller, N. Papanikolopoulos, V. Morellas, and A. Truskinovsky. *Class saliency maps reveal computer vision's basis for diagnosing metastatic carcinoma in lymph nodes*, Annual Meeting of the US and Canada Academy of Pathology (USCAP), 2019.
2. N. Heller, M. Tradewell, J. Dean, V. Morellas, N. Papanikolopoulos, N. Sathianathen, and C. Weight. *A balance cascade of deep neural networks for CT renal segmentation*, Poster Annual Meeting of the Engineering Urology Society, 2018.
3. X. Li, V. Morellas, N. , A. M. Truskinovsky. *The Use of Computer Vision in the Differential Diagnosis of Ovarian Carcinomas*, Annual Meeting of the United States and Canadian Academy of Pathology (USCAP), 2016.
4. T. Morris, D. J. Cook, V. Morellas and N. Papanikolopoulos. *A comprehensive truck parking space availability system for real-time information and parking facilities performance monitoring*, Logistics, Trade and Transportation Symposium, 2014.
5. A. Kaplan, X. Li, R. Sivalingam, G. Somasundaram, A. Banerjee, V. Morellas, N. Papanikolopoulos and A. Truskinovsky. *Computer vision methods in surgical pathology: diagnosing carcinoma of the breast* , Annual Meeting of the United States and Canadian Academy of Pathology (USCAP), volume 93, pp. 380A-380A, 2013.
6. T. V. Spina, M. Tepper, A. Esler, V. Morellas, N. Papanikolopoulos, A. X. Falcao, and G. Sapiro. *Video human segmentation using fuzzy object models and its application to body pose estimation of toddlers for behavior studies*, In arXiv preprint arXiv:1305.6918, 2013.

7. N. Walczak, J. Fasching, W. Toczyski, R. Sivalingam, N. Bird, K. Cullen, V. Morellas, B. Murphy, G. Sapiro and N. Papanikolopoulos. *A nonintrusive system for behavioral analysis of children using multiple RGB+ depth sensors*, In IEEE Workshop on Applications of Computer Vision (WACV), pp. 217–222, 2012.
8. R. Sivalingam, G. Somasundaram, X. Li, J. C. Henriksen, A. Banerjee, V. Morellas, N. Papanikolopoulos, A. Truskinovsky. *Diagnosing adenocarcinoma of the prostate by computer vision methods*, Annual Meeting of the United States and Canadian Academy of Pathology (USCAP), volume 92, pp. 394A-394A, 2012.
9. R. Sivalingam, G. Somasundaram, A. Ragipindi, A. Banerjee, V. Morellas, N. Papanikolopoulos, A. Truskinovsky. *Diagnosing endometrial carcinoma via computer-assisted image analysis*, Annual Meeting of the United States and Canadian Academy of Pathology (USCAP), 2011.
10. K. A. Patwardhan, G. Sapiro and V. Morellas. *A graph-based foreground representation and its application in example based people matching in video*, Institute of Mathematics and its Applications (IMA), University of Minnesota, preprint series No. 2154, 2007.
11. K. A. Patwardhan, G. Sapiro and V. Morellas. *Pixel layering and layer propagation for video modeling and foreground detection*, In Institute of Mathematics and its Applications (IMA), University of Minnesota, preprint series No. 2080, 2005.
12. V. Morellas, T. Morris, L. Alexander and M. Donath. *Between the lines: A driver-assistive technology for staying in the lane*, In GPS World, volume 9, 1998.
13. R. Bodor, M. Donath, V. Morellas and D. Johnson. *In-Vehicle GPS-Based Lane Sensing to Prevent Road Departure*, In Abstracts of the Third World Congress on Intelligent Transport Systems, Intelligent Transportation: Realizing the Future, 1996.

Technical Reports

1. T. Morris, X. Li, V. Morellas and N. Papanikolopoulos. *Video detection and classification of pedestrian events at roundabouts and crosswalks*, Technical report, Intelligent Transportation Systems Institute, Center for Transportation Studies, 2013.
2. E. Holec, G. Somasundaram, N. Papanikolopoulos and V. Morellas. *Monitoring the use of HOV and HOT lanes*, Technical report, Intelligent Transportation Systems Institute, Center for Transportation Studies, 2013.
3. G. Somasundaram, V. Morellas and N. Papanikolopoulos. *Deployment of practical methods for counting bicycle and pedestrian use of a transportation facility*, Technical report, Intelligent Transportation Systems Institute, Center for Transportation Studies, 2012.
4. P. Modi, V. Morellas and N. Papanikolopoulos. *Counting Empty Parking Spots at Truck Stops Using Computer Vision*, Technical report, Intelligent Transportation Systems Institute, Center for Transportation Studies, 2011.
5. G. Somasundaram, V. Morellas and N. Papanikolopoulos. *Practical methods for analyzing pedestrian and bicycle use of a transportation facility*, Technical report, Intelligent Transportation Systems Institute, Center for Transportation Studies, 2010.
6. I. Pavlidis, P. Symosek, V. Morellas, B. Fritz, N. Papanikolopoulos and R. Sfarzo. *Automatic passenger counting in the HOV Lane*, Technical report No. Mn/DOT 2000-06, Intelligent Transportation Systems Institute, Center for Transportation Studies, 1999.
7. L. Alexander, S. Bajikar, H. M. Lim, V. Morellas, T. Morris and M. Donath. *Safetruck: sensing and control to enhance vehicle safety*, Technical report No. Mn/DOT 1998-29, Intelligent Transportation Systems Institute, Center for Transportation Studies, 1997.

8. L. Alexander, M. Donath, M. Hennessey, V. Morellas and C. Shankwitz. *A lateral dynamic model of a tractor-trailer experimental validation*. Technical report No. Mn/DOT 1997-18, Intelligent Transportation Systems Institute, Center for Transportation Studies, 1996.
9. R. Bodor, L. Alexander, C. Liao, S. Bajikar, V. Morellas and M. Donath. *Analysis of a differential global positioning system as a sensor for vehicle guidance*, Technical report No. Mn/DOT 1997-17, Intelligent Transportation Systems Institute, Center for Transportation Studies, 1996.

Patents

- **Crop Models and Biometrics**, (Dimitris Zermas, Vassilios Morellas, David Mulla, Nikos Papanikolopoulos, Mike Bazakos), OTC Docket No.: 20180265, University of Minnesota, 2019.
- **Automated Detection of Nitrogen Deficiency in Corn**, (Dimitris Zermas, Vassilios Morellas, David Mulla, Nikos Papanikolopoulos, Daniel Kaiser), OTC Docket No.: 20160058, University of Minnesota, 2015.
- **Computer vision approach using 3D reconstruction as a basis for parking space occupancy detection in parking facilities**, (Doug Cook, Vassilios Morellas, Ted Morris, Nikos Papanikolopoulos), OTC Docket No.: 20140124, University of Minnesota, 2014.
- **System and method for autonomous object tracking**, (Kartik B Ariyur, Saad J Bedros, Dennis W StreLOW, Vassilios Morellas), 2011. (US Patent 7,907,750)
- **Object tracking system**, (Vassilios Morellas, Michael E Bazakos, Yunqian Ma, Andrew Johnson), 2010. (US Patent 7,720,257)
- **Face detection and tracking in a wide field of view**, (Michael E Bazakos, Vassilios Morellas), 2010. (US Patent 7,806,604)
- **Distributed stand-off ID verification compatible with multiple face recognition systems (FRS)**, (Michael E Bazakos, David W Meyers, Vassilios Morellas), 2010. (US Patent 7,817,013)
- **Infrared and visible fusion face recognition system**, (Michael E Bazakos, Vassilios Morellas, Yunqian Ma), 2009. (US Patent 7,602,942)
- **Unsupervised learning of events in a video sequence**, (Michael E Bazakos, Yunqian Ma, Vassilios Morellas, others), 2009. (US Patent 7,606,425)
- **Tracking a moving object from a camera on a moving platform**, (Kartik B Ariyur, Saad J Bedros, Vassilios Morellas, others), 2009. (US Patent 7,541,565)
- **Monitoring devices**, (Karen Z Haigh, Vassilios Morellas, Liana M Kiff), 2008. (EP Patent 1,782,406)
- **Infrared face detection and recognition system**, (Michael E Bazakos, Vassilios Morellas, Andrew Johnson, Yunqian Ma), 2008. (US Patent 7,469,060)
- **Tracking a moving object from a camera on a moving platform**, (Kartik B Ariyur, Saad J Bedros, Vassilios Morellas, others), 2008. (US Patent 7,411,167)
- **Face detection and tracking in a wide field of view**, (Michael Bazakos, Vassilios Morellas), 2007. (WO Patent 2,007,047,719)
- **Cooperative camera network**, (Ioannis Pavlidis, Vassilios Morellas), 2006. (US Patent 7,149,325)

- **High fidelity target identification and acquisition through image stabilization and image size regulation**, (Kartik B Ariyur, Vassilios Morellas, Saad J Bedros), 2006. (US Patent App. 11/562,563)
- **Deception detection booth**, (Ioannis Pavlidis, Vassilios Morellas, Michael Bazakos, others), 2006. (WO Patent 2,006,078,344)
- **Imaging methods and systems for concealed weapon detection**, (Donald R Singh, Vassilios Morellas), 2006. (EP Patent 1,721,192)
- **Controlled environment thermal image detection system and methods regarding same**, (Ioannis Pavlidis, Michael E Bazakos, Vassilios Morellas), 2006. (US Patent 7,138,905)
- **Method for monitoring a moving object and system regarding same**, (Ioannis Pavlidis, Vassilios Morellas), 2004. (EP Patent 1,399,889)
- **Method and apparatus for tracking with identification**, (Anthony E Faltesek, Vassilios Morellas), 2004. (EP Patent 1,388,140)

Invited Talks

- **Key Note Talk:** *Video analytics for security and transportation applications*, 4th Joint IEEE International Workshop on Object Tracking and Classification Beyond the Visible Spectrum (OTCBVS'07), June 22, 2007.
- *A pragmatic view on modern video surveillance systems*, Advanced Transportation Technologies Seminar Series, Institute for Transportation Studies (ITS), University of Minnesota, October 9, 2007.
- *Imaging methods for surveillance*, IMA/MCIM Industrial Problems Seminar, Institute for Mathematics and Its Applications (IMA), University of Minnesota, March 3, 2006.
- *Advanced technology for homeland security applications*, Institute for Transportation Studies (ITS), University of Minnesota, June 2, 2003.

Student Advising and Mentoring

Master Thesis

- Haoyuan Du, Haoyi Shi, MS 2023
Thesis: *Advancing the Functionalities of a Socially-Assistive Robot as a Companion for Aging Adults.*
- Doug J. Cook, MS 2012
Thesis: *Parking space occupancy detection utilizing 3D reconstruction techniques.*
- Luis Guzman, MS 2021
Thesis: *Robotic Embodiment of Human-Like Motor Skills via Sim-to-Real Reinforcement Learning.*
- Matthew Tlachac, MS 2021
Thesis: *Tumbling Robot Optimization Using a Learned Control Policy.*

Doctoral Dissertations

- Anoop Cherian, PhD 2013
Thesis: *Similarity search in visual data.*
Current Appointment: Mitsubishi Electric Research Laboratories, Boston, MA.
- Ravishankar Sivalingam, PhD 2013
Thesis: *Tensor sparse coding for positive definite matrices.*
Current Appointment: 3M, St. Paul, Minnesota.

- Guruprasad Somasundaram, PhD 2012
Thesis: *Salient image regions for enhancing segmentation object detection and intra-class diversity.*
Current Appointment: 3M, St. Paul, Minnesota.
- Panagiotis Stanitsas, PhD 2018
Thesis: *Machine Learning Methods with Emphasis on Cancerous Tissue Recognition.*
Current Appointment: 3M, St. Paul, Minnesota.
- Dimitrios Zermas, PhD 2018
Thesis: *Combining Machine Learning with Computer Vision for Precision Agriculture Applications.*
Current Appointment: Accepted a job offer from Sentera LLC, Bloomington MN.

PhD Thesis Committees

- Kedar Patwardhan, Jon Andersh.

Synergistic Activities

- Associate Editor, IEEE/RSJ International Conference on Intelligent Robots and Systems, 2019.
- Technical Committee, 22nd International Conference on Pattern Recognition (ICPR 2014).
- Program Committee, IEEE International Symposium on Safety, Security, and Rescue Robotics, (Years 2012, 2013).
- Program Area Chair, 5th IEEE International Conference on Advanced Video and Signal Based Surveillance, 2008.
- Program Committee, IEEE Workshop on Computer Vision Beyond the Visible Spectrum: Methods and Applications, in conjunction with CVPR (Years 2000, 2001).