

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

AVIDBOTS CORP. and AVIDBOTS USA CORP.,

Petitioners,

v.

BRAIN CORPORATION,

Patent Owner.

Case IPR2025-01601
U.S. Patent 10,379,539

**DECLARATION OF MARILYN C. WOLF IN SUPPORT OF PATENT
OWNER'S PRELIMINARY RESPONSE**

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

I reserve the right to supplement my opinions in the future to respond to any arguments or positions Petitioners may raise, taking account of new information as it becomes available to me.

Date: 4 March 2026

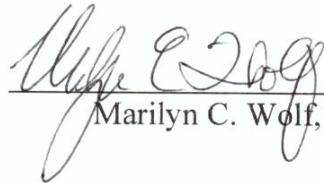

Marilyn C. Wolf, Ph.D.

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I, Marilyn Claire Wolf, declare as follows:

1. My name is Marilyn Claire Wolf. I have been retained by Knobbe, Martens, Olson & Bear, LLP, counsel for Patent Owner Brain Corporation (“Brain”) as an independent expert witness in this proceeding. I am making this declaration at the request of Brain in the matter IPR2025-01601, which concerns the claims of U.S. Patent No. 10,379,539 (“539 Patent”).

2. I am being compensated by Brain for my work in this matter at my standard rate of \$600 per hour for expert consulting services. My compensation is in no way dependent on the outcome of this proceeding.

I. QUALIFICATIONS

3. My qualifications are set forth in my curriculum vitae, a copy of which is included as Exhibit 2051. A summary of my qualifications follows.

4. I currently serve as Koch Professor of Engineering at the University of Nebraska – Lincoln (UNL).

5. I received my Bachelor’s, Master’s and Ph.D. degrees in Electrical Engineering from Stanford University in 1980, 1981, and 1984 respectively. I was elected to Phi Beta Kappa and Tau Beta Pi during my bachelor studies. My research interests include very large scale integrated systems (VLSI), embedded computing, and embedded computer vision.

6. From 1984 to the present, I served in various positions in academia, as well as in corporate settings. I was a Member of Technical Staff at AT&T Bell Laboratories from 1984 through 1989. I joined the Princeton University electrical engineering in 1989 and served there until 2007. During that time, I held various academic positions at Princeton University, including assistant professor of electrical engineering, associate professor of electrical engineering, and professor of electrical engineering. As a professor of electrical engineering at Princeton University, I taught courses on embedded computing, VLSI design, computer-aided design, computer architecture, and multimedia. In 2007, I accepted a position as a Professor, Farmer Distinguished Chair, and Georgia Research Alliance Eminent Scholar at the Georgia Institute of Technology's School of Electrical and Computer Engineering. During my time at Georgia Institute of Technology, I taught classes in embedded computing and electrical and computer engineering and I was also responsible for conducting and supervising research in these areas. I also was involved in research and wrote *The Physics of Computing*. In 2019, I accepted a position as a Professor of Engineering and Chair for the Department of Computer Science and Engineering at the University of Nebraska, where I led the formation of the School of Computing and have been responsible for researching and teaching various engineering projects and proposals.

7. I have also held a number of positions with both major corporations and start-ups. From 1984 to 1989, I was a member of the technical staff at AT&T Bell Laboratories where I conducted research in computer aided design of digital systems, and was also responsible for supervising the work of co-op and summer students. From 2001 to 2002, I held positions at MediaWorks Technology, including Chief Scientist, Principal SoC Architect and Chief Technical Officer. In these positions, I was responsible for product definition, technology development, and chip design. From 2003 to 2013, I co-founded and was employed by Verificon Corporation, which is a company that developed and licensed smart camera technology for surveillance and industrial applications.

8. I am a co-inventor on nine U.S. Patents. These patents cover various technologies, including object identification and behavior characterization using video analysis, object code compression, automated video activity analysis, video browsing, and flow detection and motion analysis. One example is U.S. Patent No. 7,200,266, titled “Method and apparatus for automated video activity analysis.” The patent describes a novel method and apparatus to detect the presence of articulated objects, such as the human body and other objects, and to identify their activities in compressed and uncompressed domains and in real-time.

9. I have authored or co-authored over 300 technical publications, including four textbooks.

10. I also have significant experience in the research and development of autonomous robots such as unmanned aerial vehicles (UAVs). A few of my publications regarding my work on UAVs include: “Achieving Resiliency and Behavior Assurance in Autonomous Navigation: An Industry Perspective,” *Proceedings of the IEEE*, 108(7), July 2020, pp. 1196-1207; "Attention-Based Activation Pruning to Reduce Data Movement in Real-Time AI: A Case-Study on Local Motion Planning in Autonomous Vehicles," *IEEE Journal on Emerging and Selected Topics in Circuits and Systems*, vol. 10, no. 3, pp. 306-319, Sept. 2020; “Closed-Loop Approach to Perception in Autonomous System,” 2021 Design, Automation & Test in Europe Conference & Exhibition; "Task-Driven RGB-Lidar Fusion for Object Tracking in Resource-Efficient Autonomous System," in *IEEE Transactions on Intelligent Vehicles*, vol. 7, no. 1, pp. 102-112, March 2022; “Autonomous UAV Landing on a Moving UAV using Machine Learning,” AIAA SCITECH 2022 Forum, 2022; "Machine Learning Components for Autonomous Navigation Systems," In *Embedded Machine Learning for Cyber-Physical, IoT, and Edge Computing: Use Cases and Emerging Challenges*, pp. 201-231; and “Adaptive Perception Control for Aerial Robots with Twin Delayed DDPG,” 2024 Design, Automation & Test in Europe Conference & Exhibition, Valencia, Spain, 2024, pp. 1-6.

11. I have received the ASEE Terman Award, IEEE Circuits and Systems Society Education Award, IEEE Computer Society Harry H. Goode Memorial Award, and IEEE Leon K. Kirchmayer Graduate Teaching Award. I am also a Fellow of the IEEE and ACM and an IEEE Computer Society Golden Core member.

12. I have supervised the dissertations of 28 Ph.D. students, including those titled *Hardware-Software Co-Synthesis of Embedded Real-Time Multiprocessors* (1998); *Design and Analysis of a Real-Time Video Human Gesture Recognition System* (2004); *Multi-Camera Systems: Tracking on Peer-to-Peer Systems, Patio-Temporal Event Detection, and Video Synchronization* (2006); *Design and Implementation of Distributed Real-Time Camera Systems* (2007); *Distributed Multi-Modal Human Activity Analysis: From Algorithms to Systems* (2007); *Detecting and Tracking Moving Objects From a Moving Platform* (2012); and *Closed Loop Perception for Resource Efficient Autonomous Systems* (2022).

13. I am active in several professional organizations, including the IEEE, ACM, and ASEE. As noted above, I have been elected a Fellow of both the IEEE and ACM and I received the ASEE Terman Award. As part of my work with those organizations, I have helped to found several conferences and workshops, including Embedded Systems Week, MPSoC, and ICDSC. I have served on the board of the IEEE Circuits and Systems Society. I was the founding Vice President for Finance for the IEEE Council on Electronic Design Automation.

II. MATERIALS AND INFORMATION CONSIDERED

14. I have been asked to provide technical expert opinions relating to the validity of the claims of the '539 Patent. In forming my opinions expressed in this Declaration, I have reviewed and considered the '539 Patent's claims, specification, drawings, and file history. I have also reviewed and considered Avidbot's Petition, the prior art references that Petitioner relies on, the Declaration of Nikolaos Papanikolopoulos (EX1003) accompanying the petition, and all other exhibits Petitioner submitted, including Exhibits 1001 through 1015.

15. I have further reviewed and considered at least the following materials in preparing this Declaration:

Exhibit No.	Description
EX2052	Voronoi Diagrams, Professor Diane Souvaine, Michael Horn, Julie Weber, Tufts University (2005)
EX2053	David Miller, <i>A Spatial Representation System for Mobile Robots</i> , Yale University (1985)

To the extent not listed above, I have also reviewed any other materials referenced expressly or implicitly herein.

16. In forming my opinions in this Declaration, I have also relied upon my educational and professional experience.

17. Any figures appearing in this Declaration were prepared with the assistance of counsel and reflect my understanding of the '539 Patent and the materials discussed in this Declaration.

18. All *emphases* in quotes are added unless stated otherwise.

III. APPLICABLE LEGAL STANDARDS

19. I am not an attorney and I will not offer opinions of law. However, I have been informed of several principles of law concerning patent claim construction and validity, which I apply in addressing the challenged claims.

A. Claim Construction

20. I understand that, in assessing the patentability of a patent claim, the Patent Office generally construes claim terms by giving them their ordinary and customary meaning, as they would have been understood by a POSITA at the time of the invention in view of the intrinsic record (patent specification and file history). However, I understand that the inventors may, in the patent specification, expressly define a claim term to have a meaning that differs from the term's ordinary and customary meaning. I also understand that the inventors may disavow or disclaim certain claim scope, thereby departing from the ordinary and customary meaning, when the intrinsic record demonstrates that a clear and unambiguous disavowal or disclaimer has occurred. I understand that extrinsic evidence, such as relevant technical literature and dictionaries, may be useful in ascertaining how a POSITA

would have understood a claim term, but the intrinsic record is the primary source for determining the meaning of claim terms. I further understand that claim terms should be construed the same way for purposes of validity and infringement. For the purposes of this review, and to the extent necessary, I have interpreted each claim term in accordance with the principles set forth in this paragraph.

B. Anticipation

21. I understand from counsel that 35 U.S.C. § 102 is the statute that governs the determination of anticipation. I understand that under § 102, a prior art reference anticipates a claim if each and every element of a claim is found, either expressly or inherently, within the single prior art reference in the same arrangement as the claim.

22. I understand from counsel that something is “inherent” in, and therefore taught by the prior art, if it necessarily flows from the explicit disclosure of the prior art. I understand that the fact that a certain result or characteristic *may* be present in the prior art is not sufficient to establish inherency. However, if the result or characteristic is necessarily present based on the explicit disclosure in the prior art, it is inherent in the prior art and is therefore disclosed.

C. Obviousness

23. I understand from counsel that, under 35 U.S.C. § 103, a patent claim is obvious if the differences between the claimed invention and the prior art are such

that the claimed invention as a whole would have been obvious before the effective filing date to a person having ordinary skill in the art to which the claimed invention pertains.

24. I understand from counsel that the factors to be considered in an obviousness inquiry include: (1) the scope and content of the prior art, (2) the differences between the claimed subject matter and the prior art, (3) the level of ordinary skill in the pertinent art, and (4) objective considerations of nonobviousness (also referred to as secondary considerations) such as commercial success, industry praise, teaching away, long-felt need, failure of others, skepticism, unexpected results, and copying. I understand that all of these factors must be considered in an obviousness analysis. I also understand that to establish any such evidence as objective considerations of nonobviousness, a nexus must be shown between the evidence and the claimed invention.

25. I understand from counsel that the obviousness inquiry must be made without hindsight. I also understand from counsel that the POSITA cannot use the knowledge only taught by the patented invention against the patentee. I understand from counsel that care must be taken to avoid hindsight reconstruction by using the patent as a guide to combine prior art references to achieve the result of the challenged claims.

26. I understand from counsel that a reference is available as prior art if it is analogous art. I understand that a reference is analogous art if it falls with the same field of endeavor as the claimed invention or, if not, if it is reasonably pertinent to the particular problem to which the inventor is involved.

27. I understand from counsel that that the motivation to combine or modify the prior art must be clear and particular and be supported by more than conclusory statements. I also understand from counsel that the following principles signal that a motivation to make a proposed combination is lacking:

- a. If the proposed modification would render the prior art being modified unsatisfactory or inoperable for its intended purpose;
- b. If the proposed modification or combination of the prior art would change the principle of operation of the prior art being modified; and/or
- c. If the prior art teaches away from modifying or combining certain known elements.

28. I understand from counsel that even if a skilled artisan would be motivated to combine two or more prior art references, there must be a reasonable expectation that the combination would be successful. I also understand from counsel that a “reasonable expectation of success” does not require that a skilled artisan would have been absolutely certain that the invention would work for its intended purpose.

29. I understand from counsel that when combining disclosures from multiple references, combining multiple embodiments from a single reference, or selecting from large lists of elements in a single reference, there must be a motivation to make the combination and a reasonable expectation that such a combination would be successful.

D. Perspective of a Person of Ordinary Skill in the Art at the Time of the Claimed Invention

30. I have been informed that claim construction and patent validity is generally analyzed from the perspective of a person of ordinary skill in the art (POSITA) at the time of the invention. I have assumed for purposes of my analysis that the time of the invention, which may also be referred to as the “relevant time,” “effective filing date,” “critical date,” or “priority date,” is no later than November 2, 2016. I have based that assumption in part, on the November 2, 2016 filing date of patent application No. 15/341,612, which I understand is the parent application for the ’539 Patent.

31. I have performed my analyses and expressed my opinions from the perspective of a POSITA at the relevant time.

IV. BACKGROUND OF THE TECHNOLOGY

32. The ’539 Patent is titled, “Systems and Methods for Dynamic Route Planning in Autonomous Vehicles” and issued on August 13, 2019. The ’539 Patent is a continuation of an earlier application that was filed on November 2, 2016.

EX1001 at Cover. The patent explains that robots can learn routes through demonstrations by a user (“the user can control a robot along a route and/or can upload a map containing a route”) or “a robot can plan its own route in an environment based on its knowledge of the environment.” EX1001, 1:33-39. However, it can be challenging for robots to deal with changes in their environment, such as when a new obstacles appears or obstacles have shifted. *Id.* at 1:39-50. In such cases, prior art robots may struggle to make real-time adjustments to their routes, resulting in collisions or suboptimal route adjustments. *Id.*

33. The ’539 Patent discloses techniques for autonomous robot navigation that overcome these challenges and allow robots to deviate from their routes, including by making complex adjustments to avoid obstacles. For example, the ’539 Patent discloses the modeling of a robot’s route using “route poses,” wherein each route pose comprises a “footprint.” EX1001, 12:37-14:51. Unlike prior art methods which modeled robots as singular points and directions, the ’539 Patent models the robot’s “footprint” associated with the robot’s pose. *Id.* Each footprint of a route pose can comprise a plurality of points which can be used to represent the robot. *Id.*, 14:28-43, *see also id.* at Fig. 4D (reproduced below). Figure 4D illustrates an example of robot 202 traveling along a route characterized by route poses 414 and 416. As shown in Figure 4D, each route pose has a footprint with corresponding footprints as the robot travels a route.

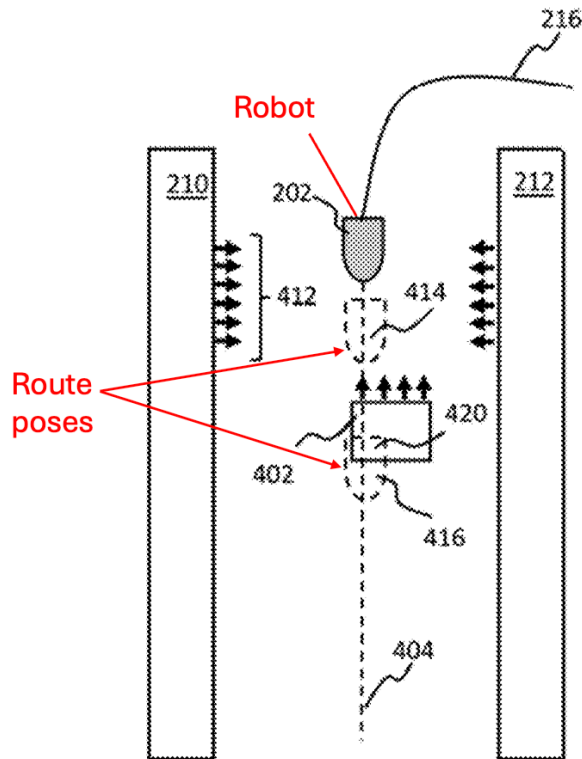


FIG. 4D

EX1001, Fig. 4D (annotated).

34. Figure 4E depicts a route pose in which a plurality of points are distributed around and within the footprint. *See id.* at Fig. 4E (below); 4:25-27. The patent explains that “a plurality of points can define the body of robot 202 as reflected in route poses ... providing representative coverage over a portion of the body of robot 202 and/or substantially all of robot 202.” *Id.* at 14:33-36. These points can experience forces, such as repulsive forces, by objects in the environment. *Id.* at 14:41-43.



FIG. 4E

35. The patent explains that the points on a robot's route pose can experience repulsive forces from obstacles which tend to push the robot away from the obstacle. *Id.* at 13:62-14:27. A route pose can also experience attractive forces, such as from points on other route poses, which pull the robot towards its originally intended path. *Id.*, 16:64-17:11; Fig. 4F. Note, these forces are algorithmic concepts, not actually physical forces. Advantageously, by having a plurality of points that can experience forces, the points of each route pose can translate and/or rotate relative to one another, causing repositioning of the route poses and changes to the robot's route. *Id.* 14:44-51.

V. LEVEL OF ORDINARY SKILL IN THE RELEVANT ART

36. I understand that validity must be assessed from the perspective of a POSITA at the time of the invention of the '539 Patent. I have been informed and understand that the level of ordinary skill in the art may be determined by various factors including: (a) the type of problems encountered in the art, (b) prior art

solutions to those problems, (c) the rapidity with which innovations are made, (d) the sophistication of the technology, and (e) the educational level of active workers in the field.

37. I understand that Petitioner has provided the following proposed definition for the level of ordinary skill in the art:

A POSITA at the time of the earliest effective filing date of the '539 Patent would have had a Bachelor's degree or higher in electrical, computer, or mechanical engineering, or computer science (or equivalent discipline) and at least two years' experience in research, design and/or development of autonomous robotics and/or robotic mapping/navigation and/or a related field. Additional education could substitute for experience, and vice versa.

Petition at 10.

38. I have reviewed Petitioner's proposed definition of the level of ordinary skill in the art. As detailed above, based on my education and my work experiences in autonomous vehicles, I met and exceeded the level of ordinary skill in the art.

39. For purposes of conducting my analysis at this pre-institution stage of this IPR, I have used Petitioner's definition of the level of ordinary skill in the art.

I do not necessarily agree with Petitioner's definition of the level of ordinary skill and reserve the right to offer opinions regarding the level of ordinary skill in the art in this or other proceedings, including to the extent that trial is instituted in this proceeding.

**VI. GROUND 1 DOES NOT SHOW ANY CLAIM WOULD HAVE BEEN
OBVIOUS**

40. Ground 1 of the Petition asserts that all claims of the '539 Patent would have been obvious over Beardsley (EX1004) and Castellanos (EX1007). In my opinion, Ground 1 fails to show that any claim would have been obvious over Beardsley in combination with Castellanos because numerous limitations are not met, as explained below.

A. Ground 1 Does Not Identify “Detected Points on One or More Objects in the Environment” (Limitation 1[a])

41. Limitation 1[a] recites, in relevant part, “one or more sensors configured to collect data about an environment proximate to the robot including detected points on one or more objects in the environment.” The Petition relies on Beardsley’s references to “sensor data 119” which is used to “determine present locations of [other] vehicles 110 in the drive space.” Petition at 24 (citing EX1004 at [0048]). However, the Petition fails to demonstrate that Beardsley discloses that whatever the “sensor” is, that it collects data about “detected points on one or more objects in the environment.” Notably, Petitioner does not point to any disclosure in Beardsley, but instead argues that a “POSITA would have understood that Beardley’s [sic] sensors collect data at ‘detected points on one or more objects in the environment,’ as was commonly known.” Petition at 24. But the Petition never explains why a POSITA would have “understood” Beardsley’s sensor to collect data

at “detected points on one or more objects in the environment.” Nor does their expert. EX1003 at ¶64.

42. The Petition also argues alternatively that “To the extent a POSITA would not have understood Beardsley to have disclosed sensors on the robot, it would have been obvious to modify Beardsley to incorporate Castellanos’ teachings regarding sensors.” Petition at 24-25. This argument also fails because the premise is faulty. Beardsley does disclose sensors on a robot, but Beardsley does not describe that those sensors collect data about “detected points on one or more objects in the environment.” EX1004 at [0047]. Thus, there is no reason to combine Beardsley with Castellanos.

43. Furthermore, the Petition fails to show that Castellanos discloses “detected points on one or more objects in the environment.” The Petition argues that Castellanos “can obtain information on ‘different types of features’” and that “This multisensory system, which can obtain information on ‘different types of features,’ constitutes detecting ‘points’ on one or more objects in the environment.” Petition at 25. But “different types of features obtained by different types of sensors” does not disclose or suggest “detected points on one or more objects in the environment.” The Petition does not explain why it equates “types of features” with “points on one or more objects.” Nor does their expert. EX1003 at ¶66. Accordingly,

the Petition fails to show that the Beardsley/Castellanos combination discloses Limitation 1[a].

B. Beardsley/Castellanos Does Not Disclose a “Respective Pose of the Robot Including a Plurality of Points Disposed Therein” and the “Respective Pose Corresponding to at Least One of Position and Orientation of the Robot” (Limitation 1[b][1])

44. Limitation 1[b][1] recites, in part, “the respective pose of the robot including a plurality of points disposed therein, the respective pose corresponding to at least one of position and orientation of the robot.” However, the Beardsley/Castellanos combination does not disclose a “respective pose corresponding to at least one of position and orientation of the robot” and it does not disclose “the respective pose of the robot including a plurality of points disposed therein.”

1. Beardsley’s Waypoints and Active Areas Do Not Correspond to Position or Orientation of the Robot

45. The Petition maps Beardsley’s waypoints and active areas to the “respective pose of the robot.” For example, the Petition argues, “[i]n Beardsley, each waypoint and/or active area corresponds to the claimed ‘position and orientation of the robot.’” Petition at 34. But these arguments are wrong because Beardsley’s waypoints and active areas represent areas where a vehicle (which may be under control of a user) can freely move. They do not represent either the position or the orientation of the robot.

46. Beardsley (U.S. Patent App. Pub. No. 2015/0284010) is a published patent application assigned to Disney Enterprises, Inc. and describes a method for shared control over movement of a vehicle within a space. EX1004 at Cover, Abstract. Beardsley explains that “[a] human driver, who may be in the vehicle or remote to the vehicle” can drive the vehicle, but control is shared with a central controller to avoid collisions or achieve other goals. *Id.* at [0004]-[0008]. Beardsley explains that a guidance trajectory can be created with a set of waypoints, where each waypoint has an “active area (where the vehicle is allowed to freely move) of a predefined radius.” EX1004 at [0058]. Figure 4 of Beardsley illustrates an example of such a trajectory with nine waypoints, labeled 1 through 9, and circles around each waypoint depicting the active areas.

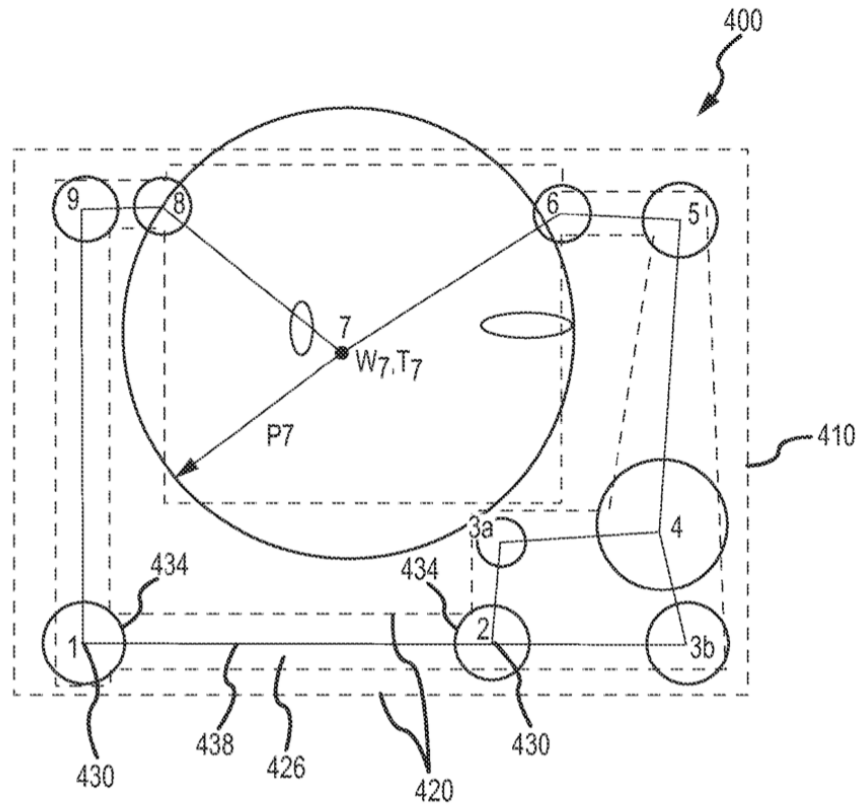


FIG.4

EX1004 at Fig. 4; *see also id.* at [0060] (“In this example, nine waypoints, w_i , are created as shown with exemplary waypoints 30 with arrival times, T_i , and a number of different radii, p_i , for their associated active areas 434.”).

47. Beardsley explains that the waypoint and active areas framework “provides an intuitive way to guide a team of vehicles throughout the drive space while giving the vehicles and their drivers/operators limited freedom in their movement via the active areas.” EX1004 at [0059]. In particular, “[a]n active area with a large radius, p , implies greater freedom of movement for the vehicle while an

active area with a small radius, ρ , imposes less freedom and accurate tracking of the vehicle along and within the guidance trajectory.” *Id.* Notably, in Figure 4 above, Beardsley explains that waypoint 7 (W7) “has a large active area where the vehicles are allowed to freely drive.” *Id.* at [0060]. Thus, a POSITA would understand that the waypoints and active areas represent areas where a vehicle is **allowed** to freely move, but do **not** correspond to the position or orientation of the robot itself.

48. Beardsley’s Figure 5 further confirms this understanding that a waypoint and active area are different from a robot and do not represent a robot’s position or orientation. Figure 5 depicts “a vehicle 510 **within** the active area 520 of the current point, q.” EX1004 at [0063]. Thus, a POSITA would have understood that Beardsley’s vehicle/robot is separate and distinct from the waypoint and active area and the waypoint and active area do not correspond to the position or orientation of the robot.

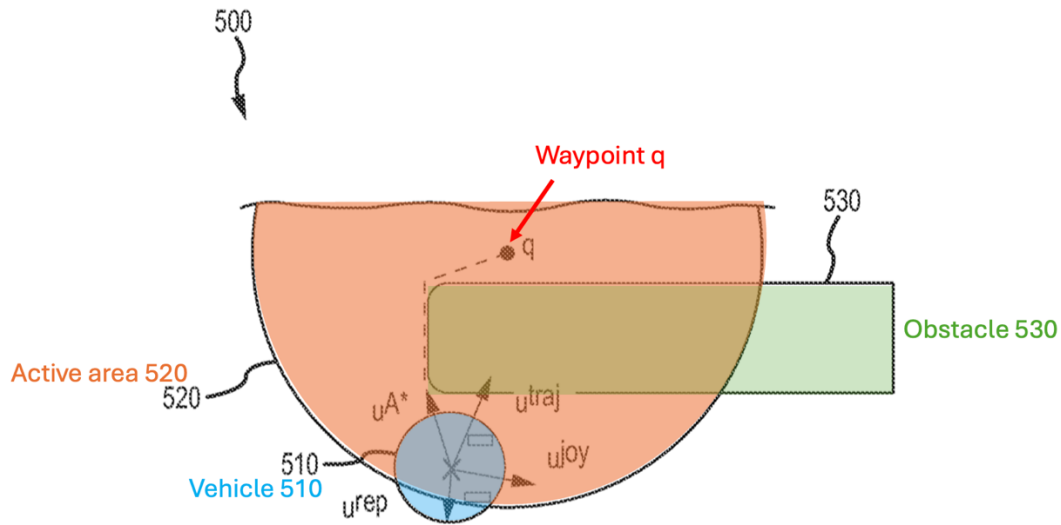


FIG.5

EX1004 at Fig. 5 (annotated).

49. By way of analogy, Beardsley’s waypoints and active areas are like a dog on a leash. The waypoint indicates where the leash is anchored or held and the length of the dog’s leash indicates the radius of the active area in which the dog is allowed to move. But the anchor location and the leash do not correspond to the actual position of the dog or which way it is pointing. Thus, Beardsley’s waypoints and active areas do not correspond to the claimed “pose of the robot” because they do not correspond to a robot’s position or orientation.

50. The Petition’s arguments further confirm that Beardsley’s waypoints and active areas do not correspond to a robot’s position and orientation. The Petition argues, “In Beardsley, each waypoint and/or active area corresponds to the claimed ‘position and orientation of the robot.’” Petition at 34-35 (citing EX1004 at [0012],

[0050], [0056]). The Petition cited the three paragraphs [0012], [0050], and [0056] from Beardsley, but none of those paragraphs were discussing Beardsley's waypoints or active areas. EX1004 at [0012], [0050], [0056].

2. Beardsley Does Not Disclose that Each Route Pose Has a Plurality of Points Disposed Therein

51. The Petition also fails to show that Beardsley discloses that each “respective pose of the robot includ[es] a plurality of points disposed therein” as required by Limitation 1[b][1]. The Petition references Beardsley's Figure 2 and argues that “each waypoint has multiple points, including point p , and points around the circle of the radius that envelopes the shape of the vehicle.” Petition at 34. This is incorrect for several reasons.

52. First, Petitioner appears to have confused Beardsley's Figure 2, which depicts a vehicle, with Beardsley's Figure 4, which depicts waypoints and active areas. Figures 2 and 4 are depicted below for reference.

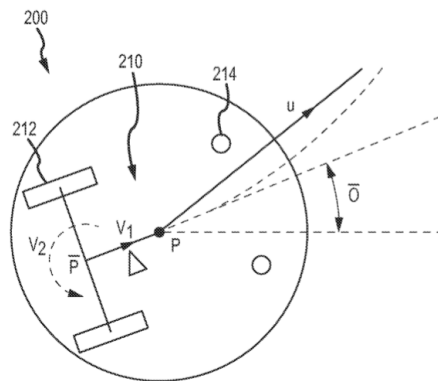


FIG.2

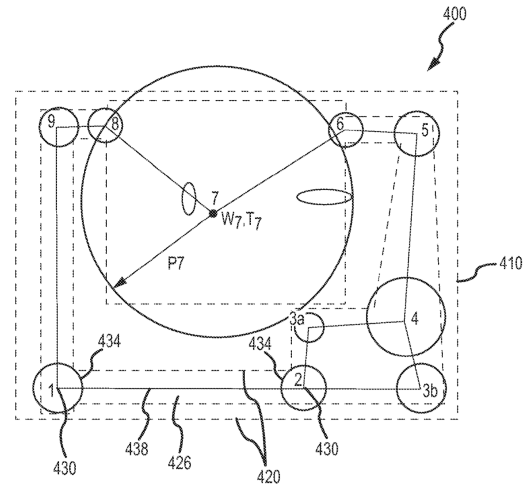


FIG.4

As discussed above, Beardsley's waypoints and active areas represent areas where a vehicle is allowed to move, not the position or orientation of a particular vehicle. In contrast, Beardsley's Figure 2 is a "graph of a wheelchair used as the semi-autonomous vehicle." EX1004 at [0015], [0056]. Beardsley explains that the point p is "the point in-between both tractor wheels" of the wheelchair. However, point p is not a point within each waypoint because, as explained above, waypoints are a separate and distinct concept from the position and orientation of the vehicle.

53. Second, the Petition does not identify a plurality of points within Beardsley. The Petition tries to identify "point p , and points around the circle of the radius that envelopes the shape of the vehicle," but does not identify any particular point "around the circle." Petition at 34. Beardsley also does not describe or call out any particular point on the circle around point p . See EX1004 at [0056], [0050]. Yet, in the relevant section discussing Limitation 1[b][2], the Petition never argues that

any forces would be calculated on any point on the supposed circle around the point *p*. See Petition at 39-40. That failure further cements that the Petition has not identified a plurality of points disposed within a route pose.

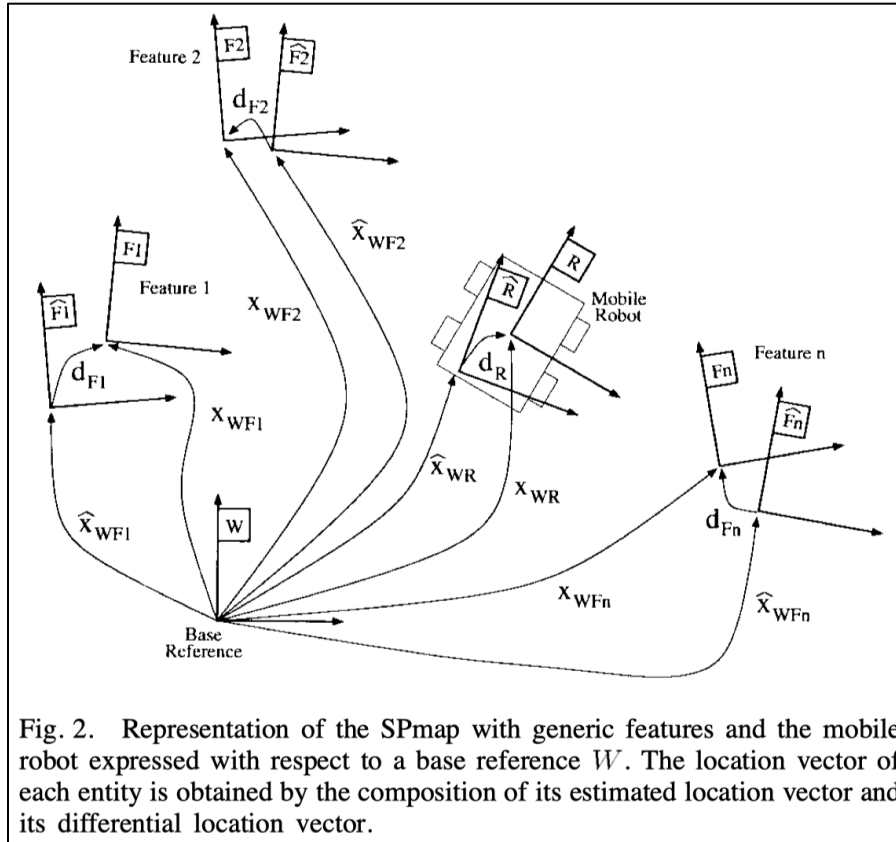
3. Castellanos Does Not Disclose a Pose of the Robot Including a Plurality of Points Disposed Therein

54. The Petition includes an alternative argument that “[t]o the extent a POSITA would not have understood Beardsley to have disclosed a ‘pose of the robot,’ it would have been obvious to modify Beardsley to use Castellanos’ route poses.” Petition at 35. The Petition then relies on Castellanos’s Figures 2, 3, and 5, and states, “[a]s illustrated in the figures, a POSITA would have understood that each pose comprises a plurality of points on the map disposed therein.” *Id.* This argument fails for several reasons.

55. First, the Petition fails to show that Castellanos discloses poses that have a plurality of points disposed therein. The Petition argues that “each pose comprises a plurality of points on the map disposed therein.” *Id.* But the Petition never identifies how Castellanos discloses a plurality of points disposed within a pose. I have reviewed Figures 2, 3, and 5 of Castellanos, but those figures do not depict any pose comprising a plurality of points. Neither the Petition nor Petitioner’s expert ever explain what in those figures they are pointing to as the purported route poses and footprints. Petition at 35; EX1003, ¶84. Figures 2, 3, and 5 are different

figures and it is unclear how the Petition is arguing that they disclose a route pose or footprint.

56. Regardless, none of Castellanos's Figures 2, 3, and 5 disclose a "pose of the robot including a plurality of points disposed therein." Castellanos was concerned with the error in locating robots and other external features in an environment. *See* EX1007 at 948-949. Castellanos describes that "The estimation of the location of an element is denoted by $\hat{x}_{WE}$, and the estimation error is represented locally by a *differential location vector* d_E relative to the reference attached to the element." *Id.*, 948 (emphasis in original). Thus, Castellanos explains that the "true location of the element" is the composition of those two vectors. *Id.* Castellanos's Figure 2 illustrates the concept of an estimated location and a differential location vector for a "Mobile Robot" and three "Feature[s]" in the environment. Notably, there is no route shown in Figure 2, thus nothing in Figure 2 shows a "respective pose of the robot" in a "route."



57. A POSITA would not understand Figure 2 to disclose a pose of the robot including a plurality of points disposed therein. Figure 2 does not depict any “plurality of points.”

58. Castellanos’s Figure 3 also does not show any pose of the robot including a plurality of points disposed therein. Figure 3 depicts matching local observations with a global map. EX1007, 949-950.

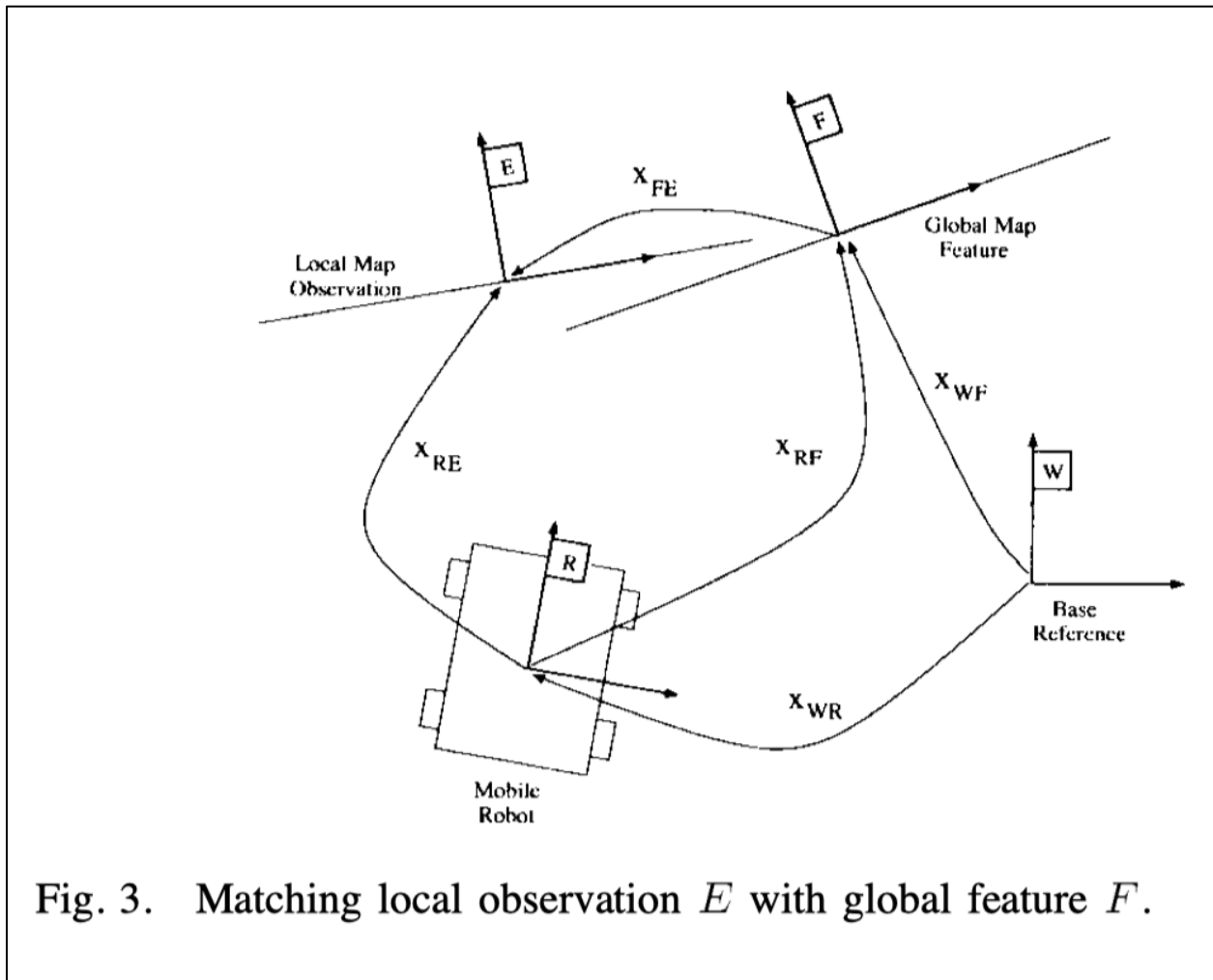
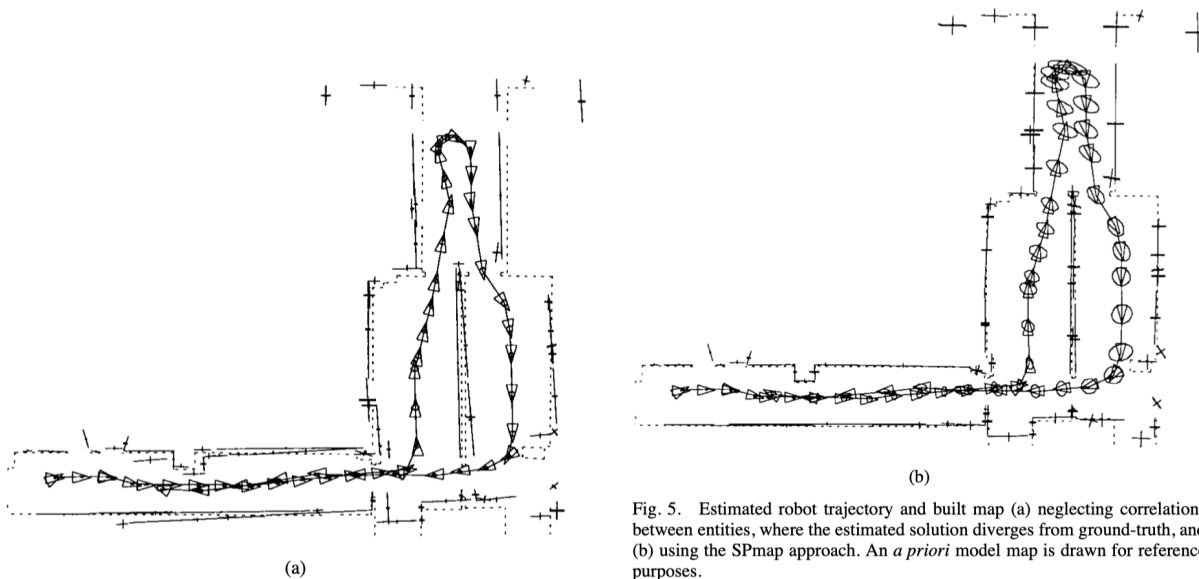


Fig. 3. Matching local observation E with global feature F .

EX1007 at Fig. 3. Figure 3 also does not show any plurality of points disposed within a pose of the robot.

59. Castellanos's Figure 5 also does not show any pose of the robot including a plurality of points disposed therein.



EX1007 at Fig. 5 (modified so that Fig. 5(a) and 5(b) are shown side-by-side instead of top-and-bottom). Figure 5 depicts two versions of an “[e]stimated robot trajectory and built map. *Id.* Here, the robot trajectories are depicted as triangles, which a POSITA would understand as illustrating only one point each and a direction.

60. Second, the Petition argued that “it would have been obvious to modify Beardsley to incorporate Castellanos’ route poses” but then never explained *how* Beardsley would have been so modified. Petition at 35. As explained above, the Petition mapped Beardsley’s waypoints and active areas to the poses of the robot (which is incorrect). But the Petition does not explain how Beardsley would be combined with Castellanos and what that combination would look like. Accordingly, in my opinion, the Petition fails to demonstrate that the Beardsley/Castellanos combination discloses a pose of the robot including a plurality of points disposed therein.

61. Accordingly, the Petition fails to demonstrate that Beardsley/Castellanos discloses Limitation 1[b][1].

C. The Petition Fails to Demonstrate that Beardsley/Castellanos Computes Forces Onto the Plurality of Points of a Pose

62. Limitation 1[b][2] recites “compute repulsive forces from a point on an object onto the plurality of points of the respective pose, the object being on the map.” The Petition fails to demonstrate that forces are calculated on more than one point.

63. The Petition argues “Beardsley discloses computing a ‘repulsive velocity u_i^{rep} ’ for each time step, for each vehicle i , using ‘a potential field approach that pushes the vehicle away from both static and dynamic obstacles.’” Petition at 39. The Petition then argues that “Beardsley’s Equation 8 provides an example of such a function.” *Id.* But the Petition fails to demonstrate that the “repulsive velocity” is determined on more than a single point. For example, the Petition tried to map the “plurality of points” to Beardsley’s point p and the circle around point p . Petition at 34. But the Petition never suggests that any forces are calculated on any point on the circle around point p . *Id.* at 39-41.

64. The Petition also inconsistently mapped Beardsley’s waypoints to the route pose. *See* Petition at 34. But again, the Petition does not argue that any forces are calculated on the waypoint either. Instead, the Petition points to Beardsley’s Figure 5 for “ u^{rep} .” Petition at 39-40. But u^{rep} is acting on the vehicle 510, not the

waypoint q . As shown below with the purple highlighting, the vector u^{rep} is acting on the vehicle 510, not the waypoint q .

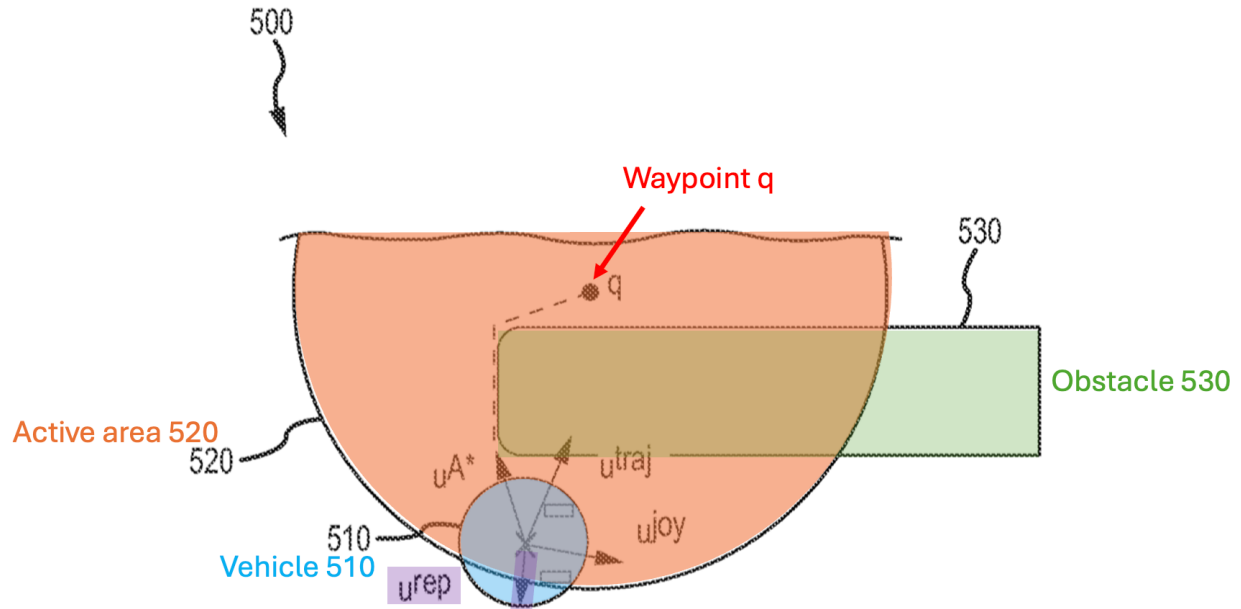
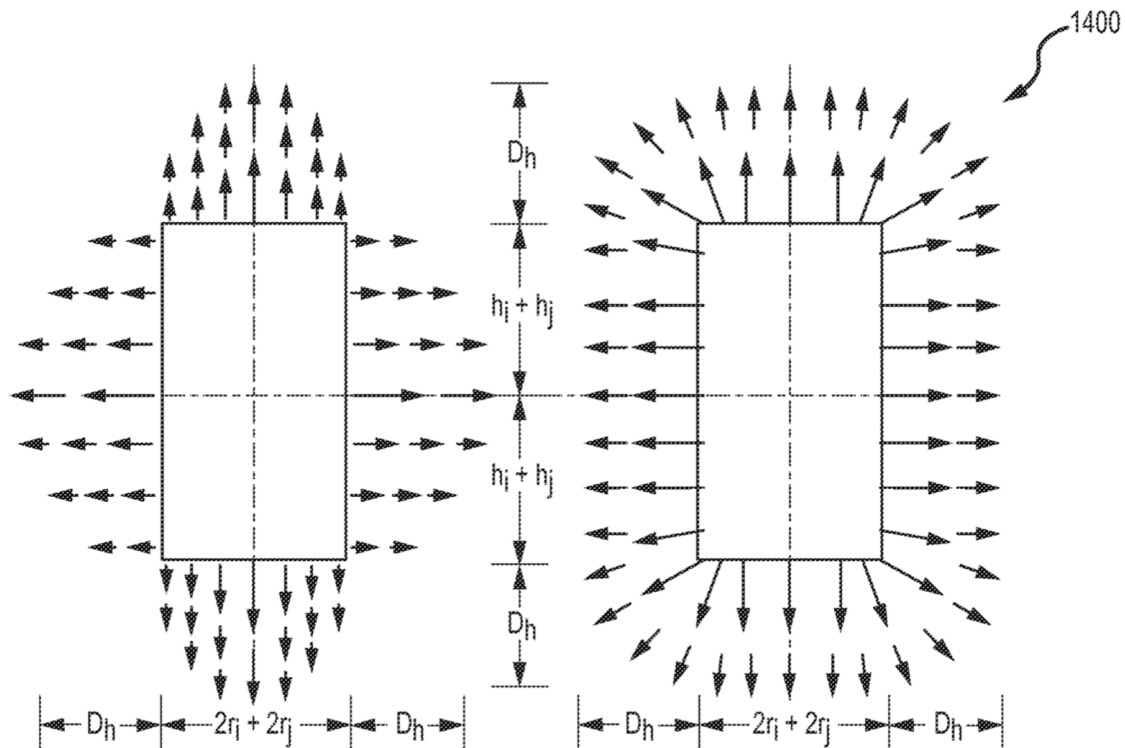


FIG.5

EX1004, Fig. 5 (annotated).

65. The Petition also relies on Figure 14 and argues that “A POSITA would have understood that Figure 14 illustrates examples of repulsive velocities ‘from a point on an object,’ which affect ‘the plurality of points of the respective pose[.]’” Petition at 39-40 (citing EX1003, ¶86). Figure 14 is reproduced below.



EX1004 at Fig. 14. But again, neither the Petition nor Petitioner’s expert explain why a POSITA would have understood that. Petition at 39-40; EX1003 at ¶86. Figure 14 does not show anything that corresponds to a “plurality of points of each route pose.” In fact, there are no waypoints, which Petitioner argued are poses of the robot, shown at all in Figure 14. Instead, Beardsley explains that Figure 14 depicts “repulsive velocities” used for “local motion planning.” EX1004 at [0027]. Local motion planning affects the vehicles, not the waypoints. *Id.* at [0020] (“local motion planning for a vehicle”); *id.* at [0089] (“local motion planning and collision avoidance for a set of decision-making agents (vehicles)”). Thus, a POSITA would

not have understood Figure 14 as showing repulsive forces computed on a plurality of points of a pose.

66. Accordingly, the Petition fails to show that the Beardsley/Castellanos combination discloses Limitation 1[b][2].

D. Ground 1 Also Fails to Demonstrate Obviousness of the Remaining Independent Claims for the Same Reasons

67. As discussed above, Ground 1 fails to demonstrate the obviousness of Claim 1 of the '539 Patent. For the same reasons, Ground 1 also fails to demonstrate the obviousness of the other independent claims, 8 and 14. Claim 8 contains the same or substantially similar requirements of “the respective pose of the robot including a plurality of points disposed therein, the respective pose corresponding to at least one of position and orientation of the robot,” and “computing repulsive forces from a point on an object in the environment onto the plurality of points of a first route pose of the one or more route poses.” Limitations 8[a] and 8[b]. Claim 14 also contains the same or substantially similar limitations of “the respective pose of the robot including a plurality of points disposed therein, the respective pose corresponding to at least one of position and orientation of the robot,” and “compute repulsive forces from a point on an object in the environment onto the plurality of points on a first route pose of the one or more route poses.” For these limitations, the Petition cross-references its Claim 1 arguments. *See* Petition at 52, 57, 60-61. Thus, for the same reasons I explained above, Ground 1 also fails to show that Claims 8 and 14 would

have been obvious. And because none of the independent claims would have been obvious, none of the dependent claims in the '539 Patent would have been obvious either.

VII. GROUND 2 DOES NOT SHOW ANY CLAIM WOULD HAVE BEEN OBVIOUS

68. Ground 2 adds Khatib to the Ground 1 combination of Beardsley and Castellanos. However, Ground 2 only addresses a few limitations and not the entirety of each claim. As discussed below, Ground 2 fails to show that any claim of the '539 Patent would have been obvious.

A. Ground 2 Does Not Address the Deficiencies With Limitations 1[b][1], 8[a], and 14[a]

69. As noted above, Ground 2 does not address every limitation of every claim. For example, it does not address Limitation 1[b][1] regarding “respective pose of the robot including a plurality of points disposed therein” and “respective pose corresponding to at least one of position and orientation of the robot.” Nor does it address the corresponding Limitation 8[a] and 14[a] in Claims 8 and 14. *See* Petition at 67-74. Accordingly, Ground 2 does not resolve the deficiencies identified above with respect to 1[b][1], 8[a], and 14[a], and thus fails to show that any claim would have been obvious.

B. Ground 2 Does Not Demonstrate that the Beardsley/Castellanos/Khatib Combination Discloses Computing Repulsive Forces from a Point on an

Object Onto the Plurality of Points of the Respective Pose (Limitations 1[b][2], 8[b], 14[b])

70. The Petition relies on Khatib's discussion of a potential field approach and argues that "[a]ny point of the robot can be subjected to the artificial potential field," and 'defines a 'Point Subjected to the Potential' as 'PSP.'" Petition at 70. The Petition then argues that "Khatib recommends calculating the forces for 'an adequate number of PSP' to protect all of the manipulator's parts at each position of the manipulator" and that "A POSITA would also have found it desirable and obvious to apply this teaching to Beardsley's robot to calculate forces for the plurality of points on a route poses of the Beardsley robot to protect all parts of the robot." Petition at 70-71. However, the Petition does not demonstrate that any repulsive forces are calculated on more than one point in the proposed Beardsley/Castellanos/Khatib combination because, as discussed above in Section VI.B, the Petition did not identify a plurality of points in each pose.

71. Additionally, the Petition also inconsistently mapped Beardsley's waypoints and active areas to the claimed "pose of the robot." See Petition at 34. Ground 2 does not change that mapping. See Petition at 67-68 (not addressing Limitation 1[b][1]). Thus, to show that repulsive forces are "computed ... onto the plurality of points of the respective pose," Ground 2 needed to show that forces are computed on Beardsley's waypoints. But again, the Petition does not mention Beardsley's waypoints or active areas in the Ground 2 argument for Limitation

1[b][2] and does not argue that any forces are computed on Beardsley's waypoints and active areas. Such an argument also would not make sense because, as explained above, Beardsley's waypoints and active areas are a different concept than Beardsley's vehicle/robot.

72. The Ground 2 arguments for Limitations 8[b] and 14[b] are also just cross-references to Limitation 1[b][2]. *See* Petition at 73-74. Accordingly, Ground 2 fails to demonstrate that the Beardsley/Castellanos/Khatib combination discloses Limitation 1[b][2], 8[b], and 14[b]. Thus, Ground 2 does not show that any claim would have been obvious.

VIII. GROUND 3 DOES NOT SHOW ANY CLAIM WOULD HAVE BEEN OBVIOUS

73. Ground 3 argues that every claim of the '539 Patent would have been obvious over Yamamoto and Khatib. For the reasons explained below, Ground 3 fails to show that any claim would have been obvious.

A. Yamamoto Does Not Disclose Route Poses Comprising a Footprint or a Plurality of Points Disposed Therein (Limitation 1[b][3])

74. The Petition argues: "Yamamoto discloses creating 'sub-goals,' 'target positions,' 'Voronoi edges,' and 'reference points' on the map which represent potential positions of the robot along the route and comprise the respective pose of the robot including a plurality of points, the pose corresponding to the position and orientation of the robot." Petition at 84. The Petition does not provide any further

explanation why these four different things supposedly map to the claimed “pose of the robot.” For example, the Petition does not provide any explanation how any of those four things comprises a “plurality of points.” A POSITA would not have understood any of them to correspond to the claimed “pose of the robot” as I explain below.

1. Yamamoto’s Sub-Goals and Target Locations Are Not Poses

75. Yamamoto’s sub-goals and target locations are not “pose[s] of the robot” on a route, do not include “a plurality of points disposed therein,” and do not “correspond[] to at least one of position and orientation of the robot.” As their names suggest, sub-goals and target locations indicate places where a robot is trying to reach, but they do not describe the *route* that a robot takes to get there. By way of analogy, a finish line for a race is like a target position, or goal, but a finish line does not represent the route that a runner or vehicle takes to reach the finish line. Yamamoto confirms this, explaining that a robot “explores a route for attaining the goal position,” meaning that the robot must determine a route to the sub-goal or target location. EX1010, 430.

76. Sub-goals and target locations also cannot be the claimed “pose[s] of the robot” because they do not have a “plurality of points disposed therein” as required. Yamamoto does not disclose that sub-goals and target locations have a

plurality of points disposed therein. Indeed, Yamamoto depicts sub-goals and target locations as singular points.

Figure 19 The topological map constructed by the proposed path planner



EX1010 at Fig. 19. Yamamoto further states, “The position of the goal is predefined as: Goal(15.0[m], -37.5[m]).” *Id.* at 429. This confirms that a sub-goal is just an x-y position—a singular point.

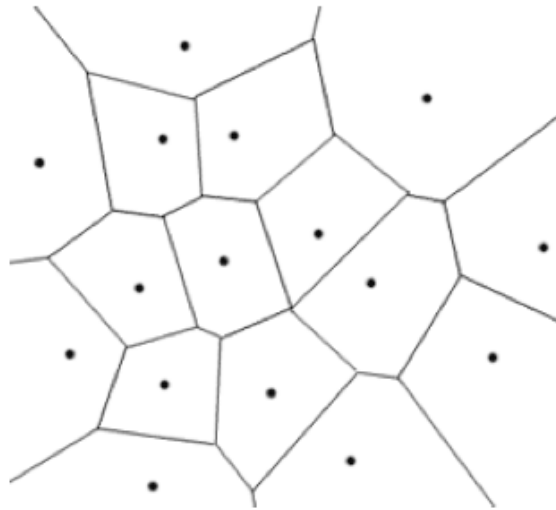
77. Additionally, sub-goals and target locations do not “correspond[] to at least one of position and orientation of the robot.” Rather, as explained above, sub-goals and target locations indicate places that a robot tries to reach, but do not necessarily correspond to the actual location or orientation of the robot.

2. **Voronoi Edges Are Not Poses of a Robot, Do Not Have a Plurality of Points Disposed Therein, and Do Not Correspond to a Robot's Position or Orientation**

78. The Petition also argues, without any explanation, that “Voronoi edges” “comprise the respective pose of the robot including a plurality of points, the pose corresponding to the position and orientation of the robot.” Petition at 84. Notably, the Petition and Petitioner’s expert never explain what a Voronoi edge is, or how it could comprise a “plurality of points disposed therein.” The Petition asserts that “Voronoi edges” “represent potential positions of the robot along the route.” *Id.* But that is not correct. A POSITA would have known and understood that Voronoi edges are a property of the map of the environment that is calculated from the map and has nothing to do with the robot itself. A Voronoi edge is not a representation of a robot’s pose along a route, do not comprise a plurality of points, and do not correspond to a robot’s position or orientation.

79. Yamamoto explains that Voronoi edges are calculated from a map. EX1010 at 428 (“In terms of modeling a configuration space of robot’s environment during navigation, we adopt Voronoi diagram approach to enable the robot to generate a map of its workspace while it is moving towards a destination.”); 429 (Yamamoto describing the “computational burden of the Voronoi edge calculation”), Fig. 14 (pseudo-code for calculating Voronoi diagram).

80. A POSITA would have known that a Voronoi diagram can be calculated from a set of points, wherein the Voronoi diagram shows cells in which any particular location within a cell is closer to that point than any other point. An example of such a Voronoi diagram is shown below, from a computational geometry course handout from Tufts University:



EX2052, 1 (showing a Voronoi diagram illustrating cells around each point, the boundaries of each cell being Voronoi edges that are equidistant to nearby points). In terms of mapping, Voronoi edges are calculated from a map of the environment and show line segments that are equidistant from nearby obstacles such as walls. Miller explains in his article, “A Spatial Representation System for Mobile Robots,” that a Voronoi diagram would “divide the regions of the map into areas such that every point in a specific area was closer to one specific edge in the region than any

other edge (see figure 5).” EX2053 at 124. Figure 5 of Miller is shown below with an example of a Voronoi diagram calculated for a particular map.

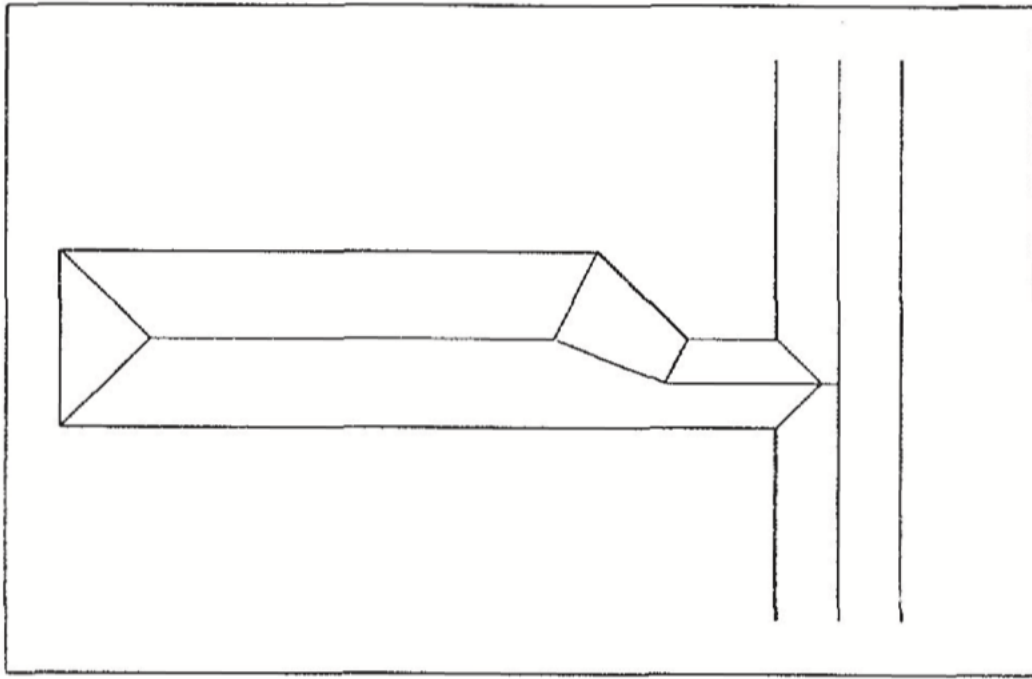


Figure 5: Voronoi Diagram of the Example Map

EX2053 at 124.

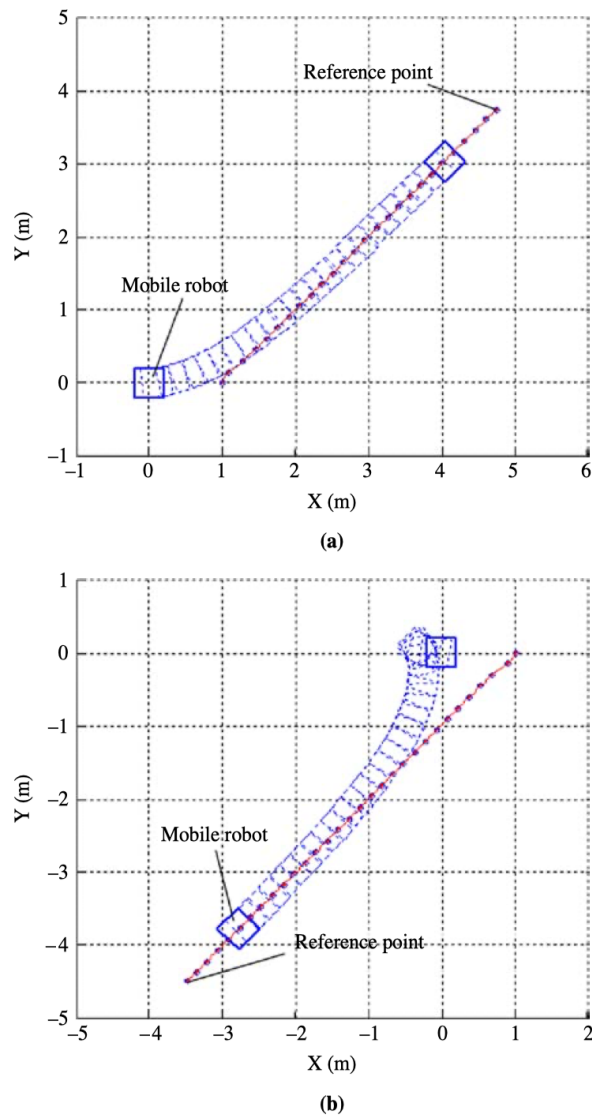
81. Because Voronoi edges are a calculated feature of a map, they are independent of any robot and do not represent poses of a robot along a route and do not correspond to a robot’s position or orientation.

3. **A Reference Point Does Not Have a Plurality of Points Disposed Therein**

82. Lastly, the Petition also attempts to map Yamamoto’s “reference points” to the claimed route poses. Petition at 84. But a reference point cannot be

the claimed route pose because it does not have a “plurality of points disposed therein” as required. A reference point is a *single* point. Yamamoto explains that it uses a “look-ahead control system” where a robot chases after a reference point. EX1010, 424. Yamamoto’s Figure 5 shows how a robot chases after a *singular* reference point.

Figure 5 Experimental result: trajectory of mobile robot: (a) 45°; (b) 225°



EX1010 at Fig. 5.

83. Yamamoto also explains that a reference point is represented by x-y coordinates, further confirming that it is just a singular point. EX1010 at 425 (“(x_r , y_r) is the coordinates of the reference point”). Indeed, the Petition never argues that a reference point has more than one point, despite the claim language requiring that “the respective pose of the robot including a plurality of points disposed therein.”

B. The Petition Fails to Demonstrate that Repulsive Forces Are Computed on the Plurality of Points of a Pose of the Robot (Limitation 1[b][2])

84. The Petition fails to demonstrate that the Yamamoto/Khatib combination discloses “compute repulsive forces from a point on an object onto the plurality of points of the respective pose.”

85. The Petition relies on equation 13 from Yamamoto, which the Petition argues calculate repulsive forces. Petition at 86. But as the Petition admits, “Yamamoto discloses using the potential field method to calculate forces for *a given reference point*.” *Id.* As discussed above, a reference point is just a singular point that the robot chases. The Petition never demonstrates how any repulsive forces are determined on a plurality of points because the Petition never identified a plurality of points.

86. Moreover, the Petition also never argues that any forces are computed on sub-goals, target locations, or Voronoi edges, which the Petition also attempted to argue were the “pose[s] of the robot.”

87. The Petition also argues that “[a] POSITA would have found it obvious to compute repulsive forces for the plurality of points of the pose as Khatib discloses defining an adequate number of PSPs would better ensure protection of the robot from collision.” Petition at 89. But again, the Petition never identified a pose of a robot that includes a plurality of points disposed therein in Yamamoto. And it is unclear how Yamamoto’s look-ahead control system, where a robot chases after a reference point, would work if it were somehow modified with one or more additional points that experience forces. Thus, the Petition does not explain how repulsive forces could be computed on more than one point within a respective pose of the robot.

88. Accordingly, the Yamamoto/Khatib combination does not disclose Limitation 1[b][2].

C. The Petition Also Fails to Demonstrate Independent Claims 8 and 14 Would Have Been Obvious

89. The Petition’s Ground 3 arguments for the remaining independent claims, 8 and 14, rely on cross-references to their Claim 1 arguments. *See* Petition at 99-102, 104-105. Thus, for the same reasons as Claim 1, Ground 3 also does not show that Claims 8 and 14, and thus all challenged claims, would have been obvious.

90. Additionally, Claims 8 and 14 also contain the additional requirement in Limitations 8[a] and 14[a] of “each route pose comprising a footprint indicative at least in part of a pose and a shape of the robot along the route.” However, Ground 3

does not address “a shape of the robot” at all in its Limitation 8[a] and 14[a] arguments. *See* Petition at 99-102, 104-105.

91. The Ground 3 argument for Limitation 8[a] also contains a cross-reference to Claim 3, but Claim 3 does not recite that a footprint is indicative of a “shape of the robot.” And the Claim 3 argument does not argue that any of Yamamoto’s sub-goals, target positions, Voronoi edges, or reference points are indicative of a shape of the robot. *See* Petition at 90-91. There is no disclosure in Yamamoto suggesting that any of those things are indicative of a shape of the robot.

92. Thus, Ground 3 fails to demonstrate Claims 8 and 14, and by extension, all challenged claims, would have been obvious.

IX. GROUND 4 DOES NOT SHOW THAT ANY CLAIM WOULD HAVE BEEN OBVIOUS

93. Ground 4 adds Scholz to Ground 1 and addresses only dependent Claims 3, 10, and 16. Petition at 106-112. Because Ground 1 fails to show that any claim would have been obvious, Ground 4 also does not demonstrate that any claim would have been obvious.

X. CONCLUSION

94. As set forth in this Declaration, it is my opinion that Avidbots has failed to demonstrate that any of the challenged claims of the ’539 Patent would have been obvious to a POSITA.

XI. RESERVATION OF RIGHTS

95. In this declaration, I have offered opinions that the claims of the '539 Patent are patentable in view of the grounds presented in Avidbots's Petition for IPR. It should be noted that my silence on any particular issue or limitation is not to be construed as agreement with Petitioner's position on that issue or an admission that any prior art reference discloses a particular limitation. I reserve the right to explain how the claims are patentable for additional reasons, including to the extent this IPR proceeding is instituted, and in other proceedings, and to present additional opinions on additional issues, such as regarding claim construction, in this or other proceedings.