

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.

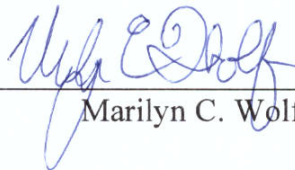
Case IPR2025-01600
U.S. Patent 10,001,780

**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: 5 Feb 2026



Marilyn C. Wolf, Ph.D.

TABLE OF CONTENTS

	Page No.
I. QUALIFICATIONS.....	1
II. MATERIALS AND INFORMATION CONSIDERED.....	6
III. APPLICABLE LEGAL STANDARDS.....	7
A. Claim Construction	7
B. Anticipation.....	8
C. Obviousness	8
D. Perspective of a Person of Ordinary Skill in the Art at the Time of the Claimed Invention	11
IV. BACKGROUND OF THE TECHNOLOGY.....	11
V. LEVEL OF ORDINARY SKILL IN THE RELEVANT ART	14
VI. GROUND 1 DOES NOT SHOW ANY CLAIM WOULD HAVE BEEN OBVIOUS.....	16
A. Beardsley/Castellanos Does Not Disclose Route Poses Comprising a Footprint and Plurality of Points (Limitation 1[b][3]).....	16
1. Beardsley Does Not Disclose Route Poses Comprising Footprints	16
2. Beardsley Does Not Disclose that Each Route Pose Has a Plurality of Points Disposed Therein.....	20
3. Castellanos Does Not Disclose a Route Pose Comprising a Footprint.....	22

4.	Castellanos Does Not Disclose that Each Route Pose Has a Plurality of Points Disposed Therein.....	28
B.	The Petition Fails to Demonstrate that the Beardsley/Castellanos Combination Determines Forces on Each of the Plurality of Points of Each Route Pose (Limitation 1[b][4]).....	28
C.	The Petition Fails to Demonstrate That Route Poses Are Repositioned In Response to the Forces	32
D.	The Petition Fails to Identify “Detected Points on One or More Objects in the Environment” (Limitation 1[a])	33
E.	Ground 1 Also Fails to Demonstrate Obviousness of the Remaining Independent Claims	35
VII.	GROUND 2 DOES NOT SHOW ANY CLAIM WOULD HAVE BEEN OBVIOUS.....	36
A.	Ground 2 Does Not Address the Deficiencies With Limitations 1[a] and 1[b][3].....	36
B.	Ground 2 Does Not Demonstrate that the Beardsley/Castellanos/Khatib Combination Discloses Determining Forces on Each of the Plurality of Points of Each Route Pose (Limitation 1[b][4])	37
C.	Ground 2 Does Not Demonstrate Repositioning the Route Poses in Response to the Forces (Limitation 1[b][5])	39
D.	Ground 2 Fails to Show that the Other Independent Claims 9 and 18 Would Have Been Obvious for the Same Reasons.....	40
VIII.	GROUND 3 DOES NOT SHOW ANY CLAIM WOULD HAVE BEEN OBVIOUS.....	41

A.	Yamamoto Does Not Disclose Route Poses Comprising a Footprint or a Plurality of Points Disposed Therein (Limitation 1[b][3]).....	41
1.	Yamamoto’s Sub-Goals and Target Locations Are Not Route Poses.....	41
2.	Voronoi Edges Are Not Route Poses of a Robot.....	43
3.	A Reference Point Is Not a Route Pose Because It Is a Singular Point	46
4.	The Petition Fails to Identify a Plurality of Points Disposed in a Route Pose.....	48
B.	The Petition Fails to Demonstrate that Repulsive and/or Attractive Forces Are Calculated on Each of the Plurality of Points of Each Route Pose (Limitation 1[b][4])	49
C.	The Petition Fails to Show that Yamamoto/Khatib Repositions Route Poses in Response to Forces (Limitation 1[b][5])	51
D.	The Petition Fails to Show that Yamamoto/Khatib Discloses “Interpolation Between One or More Route Poses” (Limitation 1[b][6])	51
E.	The Petition Fails to Demonstrate the Remaining Independent Claims Would Have Been Obvious for the Same Reasons.....	53
IX.	GROUND 4 DOES NOT SHOW THAT ANY CLAIM WOULD HAVE BEEN OBVIOUS.....	53
X.	CONCLUSION.....	54
XI.	RESERVATION OF RIGHTS.....	54

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 IPR2025-01600, which concerns the claims of U.S. Patent No. 10,001,780 (“780 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, SPIE, 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 '780 Patent. In forming my opinions expressed in this Declaration, I have reviewed and considered the '780 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 Nickolaos Papanikolopoulos (EX1003) accompanying the petition, and all other exhibits Petitioner submitted, including Exhibits 1001 through 1014.

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 '780 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 the '780 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 '780 Patent is titled, “Systems and Methods for Dynamic Route Planning in Autonomous Vehicles” and issued on June 19, 2018 from application 15/341,612, which 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, 1:25-31. 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 1:31-35. In such cases, prior art robots may struggle to make real-time adjustments to their routes, resulting in collisions or suboptimal route adjustments. *Id.* at 1:35-42.

33. The ’780 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 ’780 Patent discloses the modeling of a robot’s route using “route poses,” wherein each route pose comprises a “footprint.” EX1001, 12:28-14:41. Unlike prior art methods which modeled robots as singular points and directions, the ’780 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.*, 14:18-33, *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.

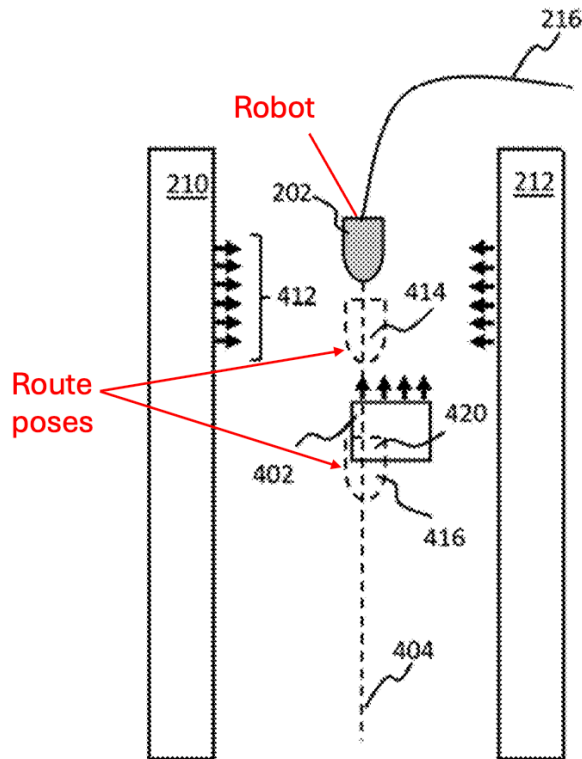


FIG. 4D

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); 4:16-18. The patent explains that “[i]n some cases, 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 14:23-26. These points can experience forces, such as repulsive forces, by objects in the environment. *Id.* at 14:31-33.



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 13:52-14:17. 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.*, 16:55-17:2; 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.* 14:34-41.

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 '780 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 '780 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 8-9.

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 '780 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. Beardsley/Castellanos Does Not Disclose Route Poses Comprising a Footprint and Plurality of Points (Limitation 1[b][3])

41. Limitation 1[b][3] recites: “generate one or more route poses on the route, wherein each route pose comprises a footprint indicative of poses of the robot along the route and each route pose has a plurality of points disposed therein.” Significantly, this limitation imposes two distinct requirements: (1) a route pose comprises a footprint indicative of poses of the robot along the route, and (2) each route pose has a plurality of points disposed therein.” The Petition argues that Beardsley and Castellanos disclose these requirements, but they do not, for reasons explained below.

1. Beardsley Does Not Disclose Route Poses Comprising Footprints

42. The Petition maps Beardsley’s waypoints to the claimed route poses and the active areas associated with each waypoint to the claimed footprints. Petition at 27. For example, the Petition argues that “Each waypoint and/or ‘active area’

corresponds to the claimed ‘route poses on the route.’ ... The ‘active area’ associated with each way point corresponds to the claimed ‘footprint indicative of poses of the robot along the route.’” *Id.* 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 footprints indicative of poses of the robot along the route.

43. 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.

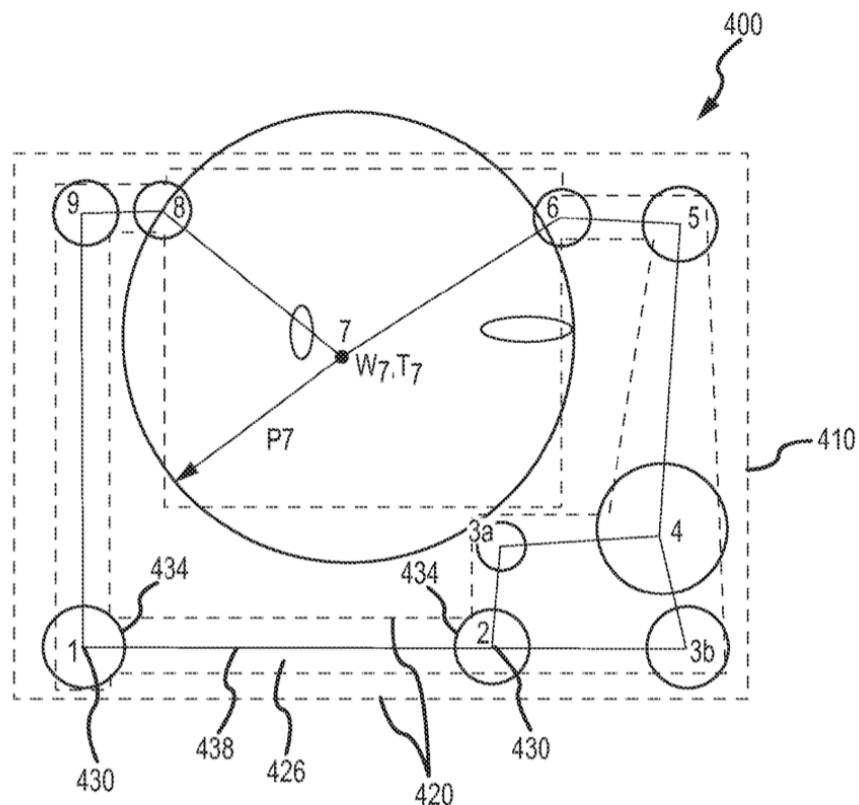


FIG.4

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.”).

44. 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 represent anything about the robot itself. Indeed, Beardsley’s waypoint and active areas provide none of the information about a robot that the ’780 Patent specification explains that a footprint can provide, such as a robot’s pose, size, and/or shape. *See* EX1001 at Abstract (“The route poses can include a footprint indicative at least in part of a pose, size, and shape of the robot along the route.”); 12:54-56 (“route poses can identify the position and/or orientation that robot 202 would travel on the route”); 13:5-46 (explaining footprints can be resized and reshaped depending on how conservative one desires to be regarding potential collisions).

45. Beardsley’s Figure 5 further confirms this understanding that a waypoint and active area are different from a robot. 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 represent a footprint of the robot.

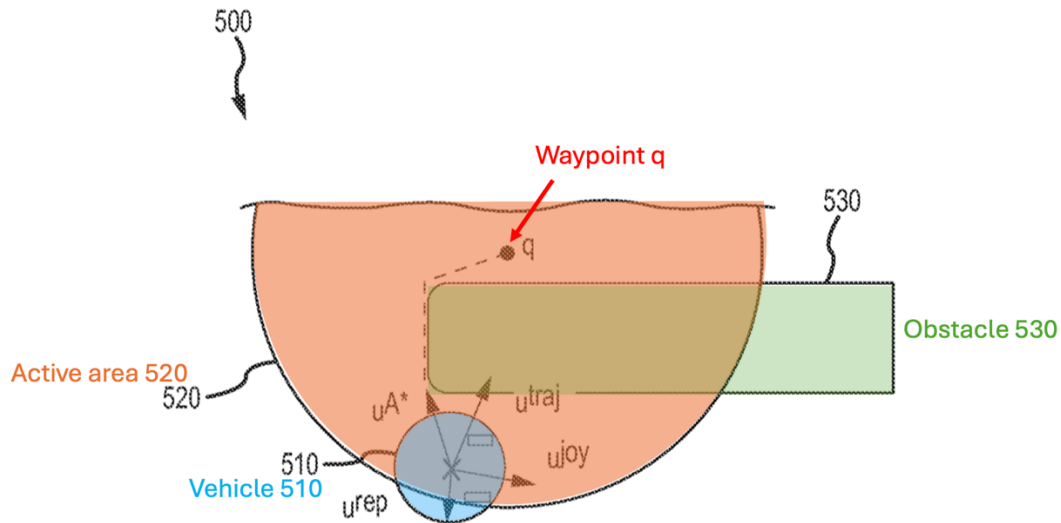


FIG.5

EX1004 at Fig. 5 (annotated).

46. 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 represent the pose or the footprint of the actual dog. Thus, Beardsley's waypoints and active areas do not correspond to the claimed route poses and footprints.

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

47. The Petition also fails to show that Beardsley discloses that "each route pose has a plurality of points disposed therein" as also required by Limitation 1[b][3]. 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 27-28. This is incorrect for several reasons.

48. 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.

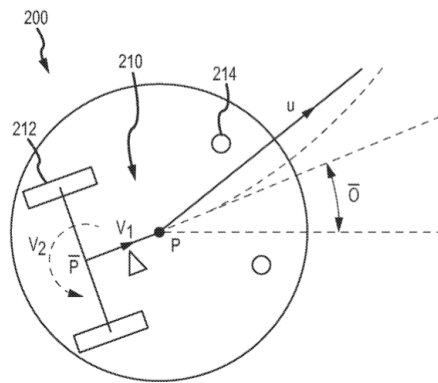


FIG.2

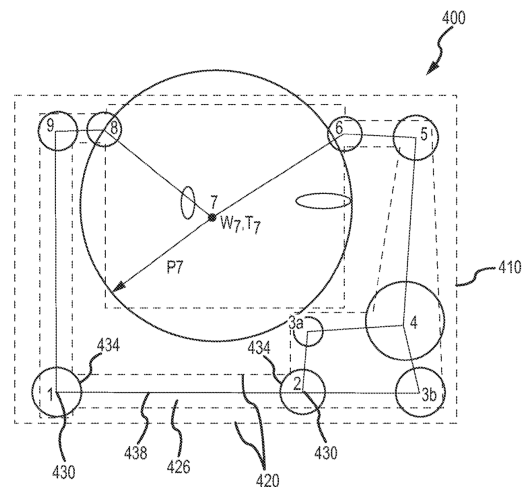


FIG.4

As discussed above, Beardsley’s waypoints and active areas represent areas where a vehicle is allowed to move, not the footprint or pose 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 and poses of the vehicle are separate and distinct concepts.

49. 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 28. Beardsley also does not describe or call out any particular point on the circle around point p . See EX1004 at [0056], [0050]. Notably, the claimed plurality of points have significance because claim 1 also requires that repulsive and/or attractive forces be determined on each of the plurality of points of the route poses. Those points are the specific points on which the forces must be calculated. Yet, in the relevant section discussing Limitation 1[b][4], the Petition never argues that any forces would be calculated on any point on the supposed circle around the point p . See Petition at 31-33. That failure further cements that the Petition has not identified a plurality of points disposed within a route pose.

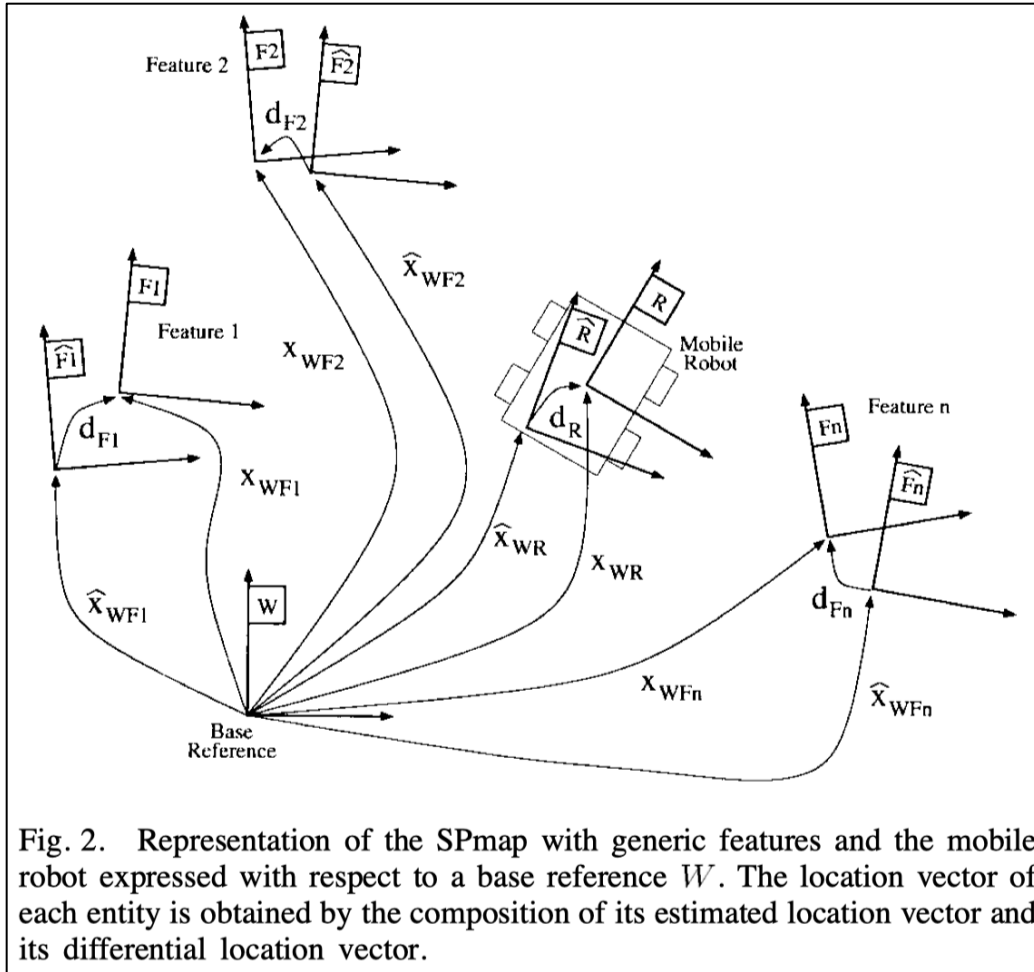
3. Castellanos Does Not Disclose a Route Pose Comprising a Footprint

50. The Petition includes an alternative argument that “To the extent a POSITA would not have understood Beardsley to have disclosed route poses on the route, it would have been obvious to modify Beardsley to use Castellanos’ route poses.” Petition at 28. This argument also fails for several reasons.

51. First, the Petition fails to show that Castellanos discloses a footprint. The Petition relies on Castellanos's description of "estimate of the mobile robot location and ... the estimation of the map features [] from a common set of observations." But a mere location alone is not a footprint. *See* EX1001 at 13:1-18 ('780 Patent using the terms "location" and "footprint" distinctly). Castellanos's reference to "map features" also do not describe a footprint either because "map features" represent external objects in the environment such as obstacles. EX1007 at 949 (explaining that the location of features are obtained from sensor observations).

52. The Petition also argues that "Castellanos further depicts poses for the mobile robot along the route in Figures 2, 3, and 5, each of which also depicts the route pose comprising a footprint of the robot along the route." Petition at 28-29. The Petition then says, "As illustrated in the figures, a POSITA would have understood that each pose comprises a plurality of points on the map disposed therein." *Id.* (citing EX1003, ¶79). I have reviewed Figures 2, 3, and 5 of Castellanos, but those figures do not depict any route pose comprising a footprint of the robot. 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 28-29; EX1003, ¶79. 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.

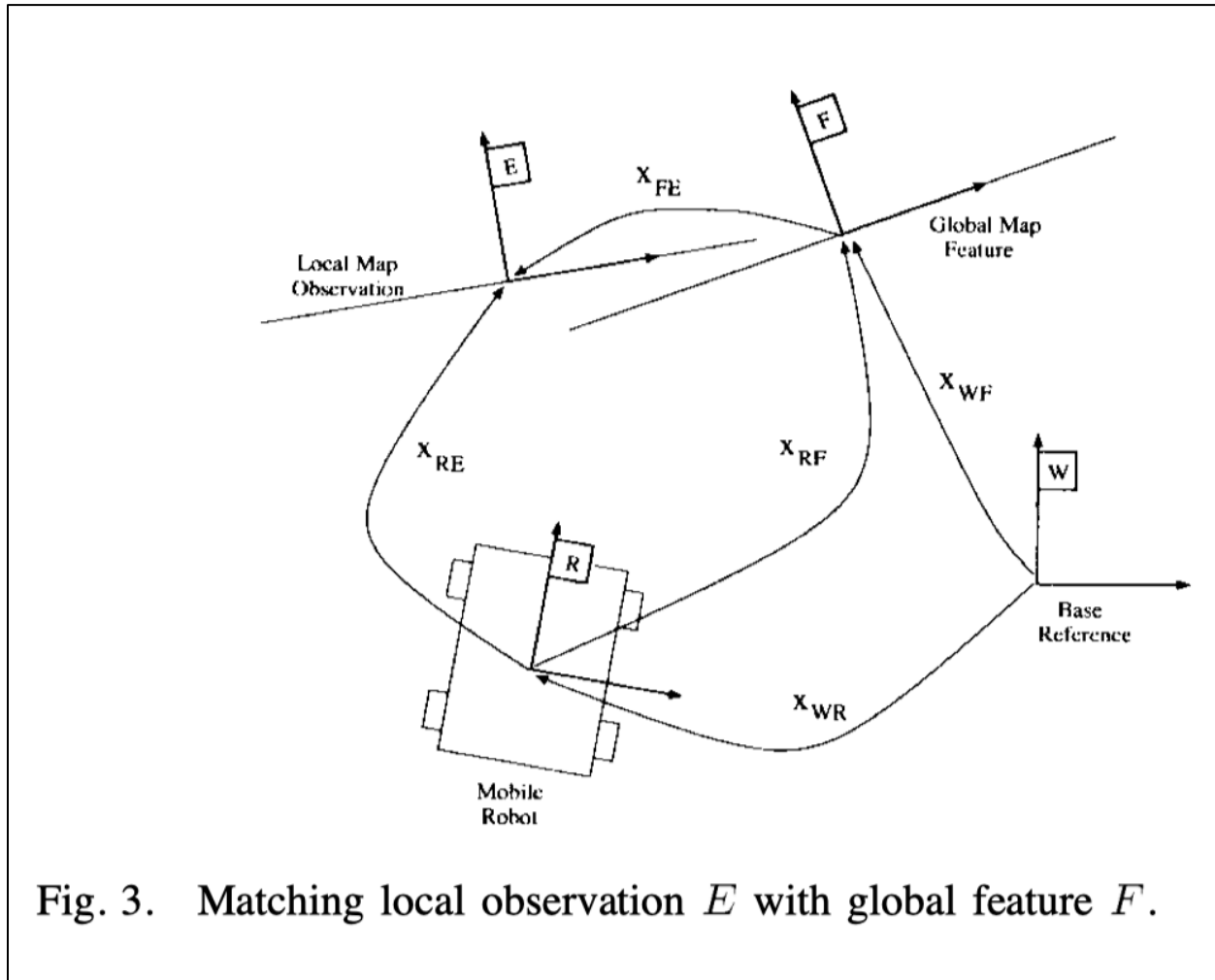
53. Regardless, none of Castellanos's Figures 2, 3, and 5 disclose a footprint. Castellanos was concerned with the error in locating robots and other external features in an environment. *See* EX1007 at 948-949. Castellanos describes that "The estimation of the location of an element is denoted by $\hat{x}_{WE}$, 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. No route is shown in Figure 2.



54. A POSITA would not understand Figure 2 to disclose a route pose comprising a footprint. Figure 2 includes a basic drawing of the “Mobile Robot” as a rectangle with four wheels, but a POSITA would have understood that that drawing is merely for the reader’s convenience in understanding the figure. Nothing in Castellanos suggests that the drawing of a robot is used in any operation. The mathematical modeling in Castellanos does not describe any representation of a footprint for the robot. See EX1007 at 948-949. Instead, Castellanos explains that a location vector is represented by “ $(x, y, \phi)^T$ ” which contains an x-y location and

direction ϕ . A POSITA would not have understood that vector to satisfy the footprint as claimed in the '780 Patent.

55. Castellanos's Figure 3 also does not show any footprint. Figure 3 depicts matching local observations with a global map. EX1007, 949-950.



EX1007 at Fig. 3. Figure 3 also contains the same basic illustration of a robot that was shown in Figure 2, but again, a POSITA would have understood that it is merely being drawn for the reader's convenience and understanding. The Petition does not identify anything that corresponds to a route pose and footprint in Figure 3.

56. Castellanos's Figure 5 also does not show any footprint.

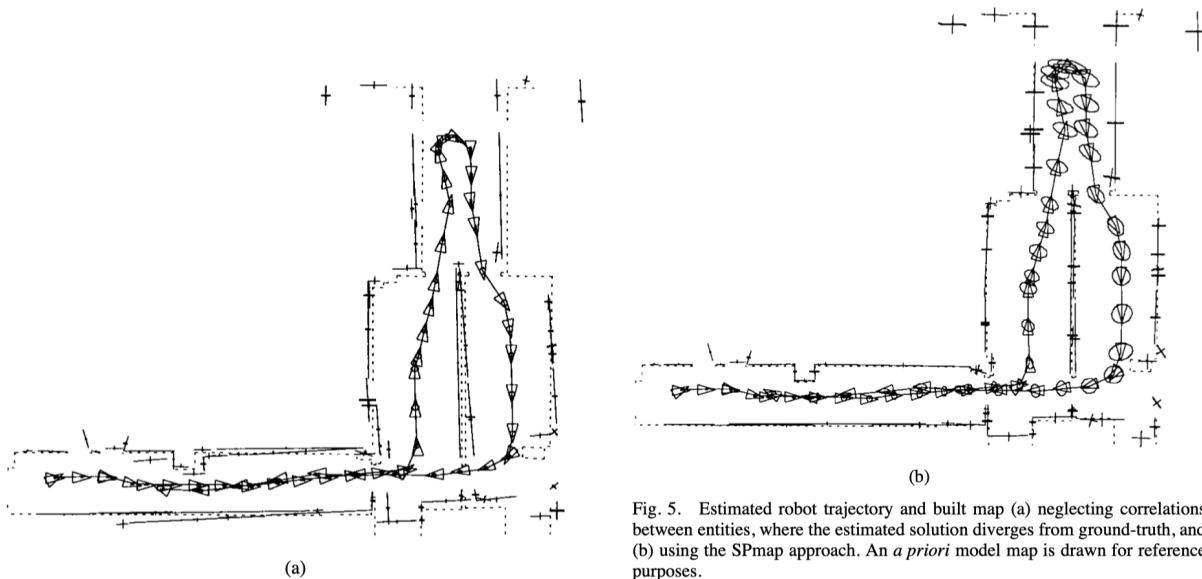


Fig. 5. Estimated robot trajectory and built map (a) neglecting correlations between entities, where the estimated solution diverges from ground-truth, and (b) using the SPmap approach. An *a priori* model map is drawn for reference purposes.

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, but a POSITA would have understood that those triangles are used to indicate the direction of the robot along the route, not the robot’s footprint. Nothing in Castellanos describes modeling the robot’s trajectory using a footprint. Instead, as described above, Castellanos at best uses a vector representing an x-y location and direction, and that is consistent with Figure 5 above. *See* EX1007 at 948-949.

57. Second, the Petition argued that “it would have been obvious to modify Beardsley to use Castellanos’ route poses” but then never explained *how* Beardsley would have been so modified. Petition at 28. As explained above, the Petition mapped Beardsley’s waypoints and active areas to the route poses and footprints

(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 route pose comprising a footprint.

4. Castellanos Does Not Disclose that Each Route Pose Has a Plurality of Points Disposed Therein

58. The Petition also fails to identify a “plurality of points disposed” in each route pose. The Petition argues in just a single sentence that “As illustrated in the figures, a POSITA would have understood that each pose comprises a plurality of points on the map disposed therein.” Petition at 29. But again, neither the Petition nor Petitioner’s expert ever explain what those points are. *Id.*; EX1003, ¶79. Both the Petition and expert declaration just reproduced Figures 2, 3, and 5 from Castellanos (which I discussed above) without any annotations or further explanation of the “plurality of points.” Nothing in Figures 2, 3, and 5 suggests a route pose that comprises a plurality of points.

59. Accordingly, for at least these reasons, the Petition fails to demonstrate that the Beardsley/Castellanos combination discloses limitation 1[b][3].

B. The Petition Fails to Demonstrate that the Beardsley/Castellanos Combination Determines Forces on Each of the Plurality of Points of Each Route Pose (Limitation 1[b][4])

60. Limitation 1[b][4] recites “determine forces on each of the plurality of points of each route pose, the forces comprising repulsive forces from one or more of

the detected points on the one or more objects and attractive forces from one or more of the plurality of points on others of the one or more route poses.” The Petition fails to demonstrate that forces are calculated on more than one point.

61. 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 31. 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 28. But the Petition never suggests that any forces are calculated on any point on the circle around point p . *Id.* at 31-33.

62. The Petition also inconsistently mapped Beardsley’s waypoints to the route pose. *See* Petition at 27. 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} .” 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 .

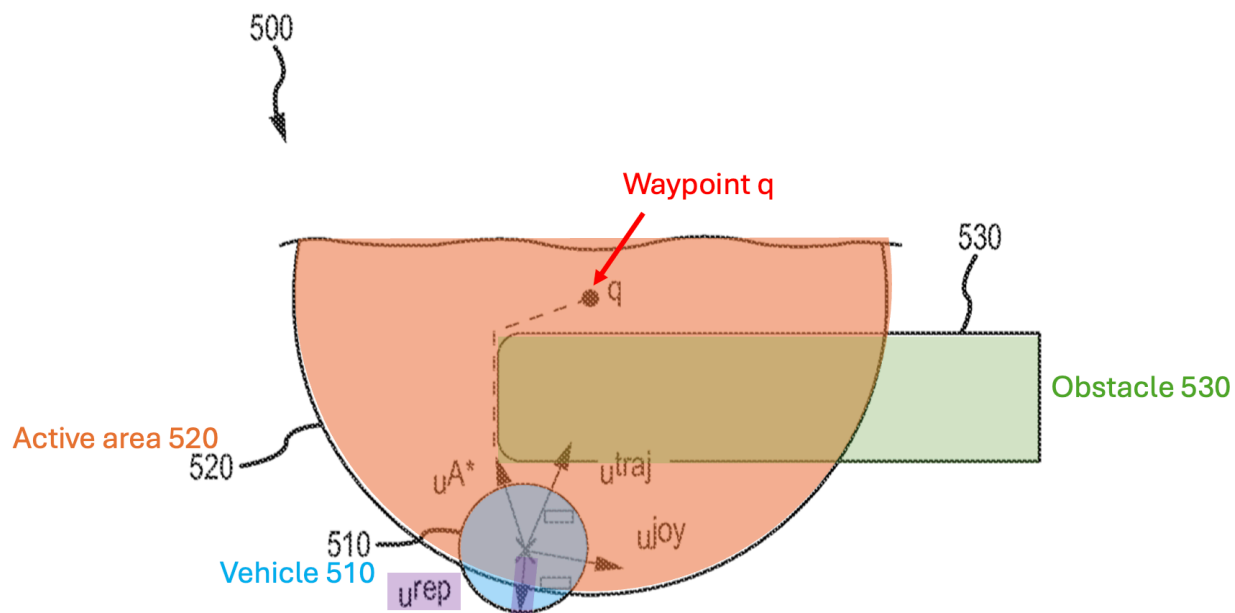
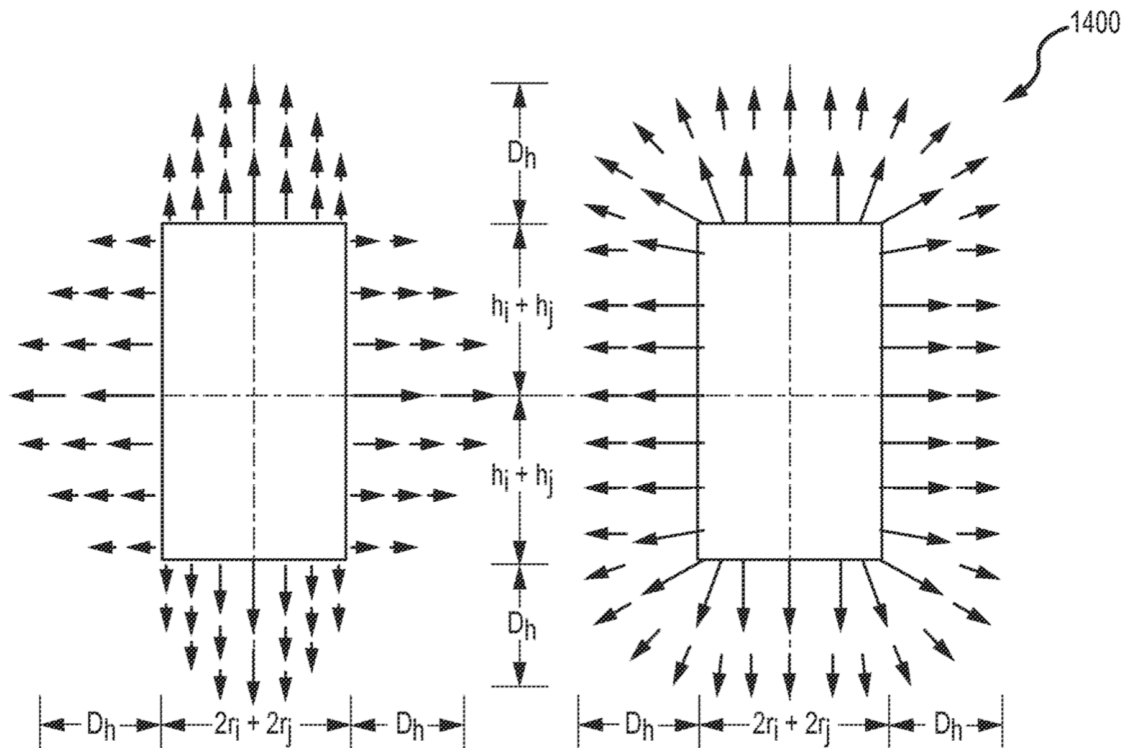


FIG.5

EX1004, Fig. 5 (annotated).

63. The Petition also relies on Figure 14 and argues that “A POSITA would have understood that Figure 14 illustrates examples of repulsive velocities ‘from one or more of the detected points on the one or more objects,’ which affect ‘each of the plurality of points of each route pose,’ as claimed.” Petition at 31. 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 31; EX1003 at ¶80. 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 route poses, 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, it does not follow

that a POSITA would have understood that Figure 14 illustrates an example of repulsive velocities affecting “each of the plurality of points of each route pose.”

64. Accordingly, the Petition fails to show that the Beardsley/Castellanos combination discloses Limitation 1[b][4].

C. The Petition Fails to Demonstrate That Route Poses Are Repositioned In Response to the Forces

65. Limitation 1[b][5] recites, “reposition one or more route poses in response to the forces on each point of the one or more route poses.” The Petition fails to demonstrate that what it identified as the route poses are ever repositioned. As noted above, the Petition argued that Beardsley’s waypoints and active areas correspond to the claimed route poses. Petition at 27 (“Each waypoint and/or ‘active area’ corresponds to the claimed ‘route poses on the route.’ ... The ‘active area’ associated with each waypoint corresponds to the claimed ‘footprint indicative of poses of the robot along the route.’”). However, the Petition does not argue at all that Beardsley’s waypoints are ever repositioned, much less repositioned in response to repulsive and/or attractive forces. Instead, the Petition argues that “Beardsley discloses using the ‘potential field approach that pushes the vehicle away from both static and dynamic obstacles.’” Petition at 33. The Petition further states that “Beardsley applies this approach to ‘local motion planning,’ ... including through ‘selectively adjusting the velocity and direction ... to generate a trajectory ... for the vehicle in the space[.]’” *Id.* But as explained above, Beardsley’s waypoints and

vehicles are different concepts. The Petition thus did not argue that Beardsley's waypoints are ever repositioned, and thus fails to demonstrate that Limitation 1[b][5] is satisfied.

66. Significantly, Beardsley does not describe that waypoints can be repositioned. For example, Beardsley describes the process of generating guidance trajectories in its Figure 3 flowchart. *See* EX1004 at Fig. 3, [0058]. The process begins with selecting a drive area or space and providing a static map of the selected drive space. *Id.* at [0057]. Then at step 320, “a set of waypoints is specified, and, for each waypoint, an arrival time, T_1 , ... and an active area (where the vehicle is allowed to freely move)” *Id.* at [0058]. Then at step 340, the method “continues with connecting consecutive waypoints.” *Id.* However, Beardsley never describes that the waypoints can reposition themselves after they are set. *See generally* EX1004. Instead, Beardsley explains that a vehicle can travel between waypoints and move freely within the active areas around each waypoint. EX1004 at [0058]-[0059]. That is not the same as the waypoints themselves being repositioned. Accordingly, the Petition fails to demonstrate that the Beardsley/Castellanos combination discloses Limitation 1[b][5].

D. The Petition Fails to Identify “Detected Points on One or More Objects in the Environment” (Limitation 1[a])

67. Limitation 1[a] recites, in relevant part, “one or more sensors configured to collect data about an environment 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 17-18 (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 Beardsley’s [sic] sensors collect data at ‘detected points on one or more objects in the environment,’ as was commonly known.” Petition at 17-18. 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.

68. 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 use Castellanos’ sensors to generate a map of the environment.” Petition at 18. 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.

69. 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 19. 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].

E. Ground 1 Also Fails to Demonstrate Obviousness of the Remaining Independent Claims

70. As discussed above, Ground 1 fails to demonstrate the obviousness of Claim 1 of the ’780 Patent. For the same reasons, Ground 1 also fails to demonstrate the obviousness of the other independent claims, 9 and 18. Claim 9 contains the same or substantially similar requirements of “each route pose comprising a footprint indicative at least in part of a pose and a shape of the robot along the route and each route pose having a plurality of points disposed therein,” “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,” and “repositioning the first route pose in

response to at least the repulsive forces.” Limitations 9[b], 9[c], 9[d]. Claim 18 also contains the same or substantially similar limitations for “footprint,” a “plurality of points,” and “compute repulsive forces from a point on an object in the environment onto the plurality of points of a first route pose.” Limitations 18[b], 18[c]. For these limitations, the Petition cross-references its Claim 1 arguments. *See* Petition at 45-46, 51-52. Thus, for the same reasons I explained above, Ground 1 also fails to show that Claims 9 and 18 would have been obvious. And because none of the independent claims would have been obvious, none of the dependent claims in the ’780 Patent would have been obvious either.

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

71. 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 ’780 Patent would have been obvious.

A. Ground 2 Does Not Address the Deficiencies With Limitations 1[a] and 1[b][3]

72. As noted above, Ground 2 does not address every limitation of every claim. For example, it does not address Limitation 1[a] regarding “detected points on one or more objects in the environment” and Limitation 1[b][3] regarding “footprint” and “plurality of points.” *See* Petition at 57 (skipping elements before

1[b][4]). Instead, Ground 2 only discusses Limitations 1[b][4] and 1[b][5] in Claim 1. Accordingly, Ground 2 does not resolve the deficiencies identified above with respect to 1[a] and 1[b][3].

B. Ground 2 Does Not Demonstrate that the Beardsley/Castellanos/Khatib Combination Discloses Determining Forces on Each of the Plurality of Points of Each Route Pose (Limitation 1[b][4])

73. 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 58-59. The Petition then argues that “Khatib recommends calculating the forces for ‘an adequate number of PSP’ to protect all of the manipulators 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 59-60. However, this argument fails because the Petition still does not demonstrate that any repulsive or attractive forces are calculated on more than one point in the proposed Beardsley/Castellanos/Khatib combination because the Petition did not identify a plurality of points in each route pose.

74. Additionally, the Petition also inconsistently mapped Beardsley’s waypoints to the claimed “route poses.” *See* Petition at 27. Ground 2 does not change that mapping. *See* Petition at 57 (not addressing Limitation 1[b][3]). Thus, to show

that forces are calculated on each of the plurality of points in a route pose, the Ground 2 needed to show that forces are calculated on Beardsley's waypoints. But again, the Petition does not mention Beardsley's waypoints in the Ground 2 argument for Limitation 1[b][4] and does not argue that any forces are calculated on the waypoints. And such an argument would not make sense because, as explained above, Beardsley's waypoints are a different concept than Beardsley's vehicle/robot.

75. The petition also fails to demonstrate that the Beardsley/Castellanos/Khatib combination determines attractive forces on the plurality of points where the attractive forces are "from one or more of the plurality of points on others of the one or more route poses," as required by Claim 1. The '780 Patent explains that route poses themselves provide attractive forces on each other such that they "pull route poses towards each other." EX1001 at 16:55-17:2, *see also* Fig. 4F (illustrating how the points on route pose 416 provide an attractive force for the points on the route pose 414).

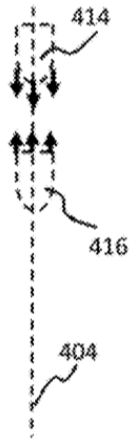


FIG. 4F

EX1001, Fig. 4F.

76. The Petition argues that in Khatib, “ F_{xd} in Equation 10 is the attractive force *from a goal point* and F_o in equation 10 is the repulsive force originating from the surface of the obstacle—thus Khatib discloses ‘determining forces.’” Petition at 49 (emphasis added). This argument ignores that the attractive forces must be from another route pose. A “goal point” is not another route pose and the Petition does not address this requirement. Accordingly, Ground 2 fails to demonstrate that the Beardsley/Castellanos/Khatib combination discloses Limitation 1[b][4].

C. Ground 2 Does Not Demonstrate Repositioning the Route Poses in Response to the Forces (Limitation 1[b][5])

77. Ground 2 also fails to demonstrate “reposition one or more route poses in response to the forces on each point of the one or more route poses” for similar reasons as Ground 1. As explained for Ground 1, the Petition mapped Beardsley’s waypoints to the claimed “route poses,” but Beardsley does not disclose that those

waypoints can be repositioned after they are initially set. Petition at 27; *see generally* EX1004.

78. When Ground 2 addresses the same limitation, the Petition argues: “Khatib further discloses the ‘displacement of a 4 *dof* manipulator’ (Fig. 2) to avoid moving obstacles—i.e., ‘repositioning one or more route poses in response to the force on each point of the one or more route poses,’ as claimed.” Petition at 60. The Petition then argues that it would have been “obvious to modify a robot according to the Beardsley/Castellanos teachings to apply Khatib’s forces onto each point of Beardsley’s robot to ensure that all points of each route pose of the robot are protected from collisions.” Petition at 61. But here, the Petition again fails to show that Beardsley’s *waypoints* are repositioned. Because the Petition argued that the waypoints are the route poses (Petition at 27), the Ground 2 fails to show that any route poses are repositioned in response to forces.

D. Ground 2 Fails to Show that the Other Independent Claims 9 and 18 Would Have Been Obvious for the Same Reasons

79. Ground 2’s arguments for Claims 9 and 18 either do not address the limitations at all (in which case they fail for the same reasons as Ground 1) or rely on a cross-reference to their Ground 2 Claim 1 arguments. *See* Petition at 64, 66. Thus, for the same reasons as Claim 1, Ground 2 fails to show that Claims 9 and 18 would have been obvious. And because none of the independent claims would have been obvious, so too none of the remaining dependent claims would have been obvious.

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

80. Ground 3 argues that every claim of the '780 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])

81. 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 route poses and footprints indicative of poses of the robot along the route.” Petition at 78. The Petition does not provide any further explanation why these four different things are considered route poses or why they are also footprints. A POSITA would not have understood any of them to correspond to the claimed “route poses” which “comprise[] a footprint indicative of poses of the robot along the route and each route pose has a plurality of points disposed therein.”

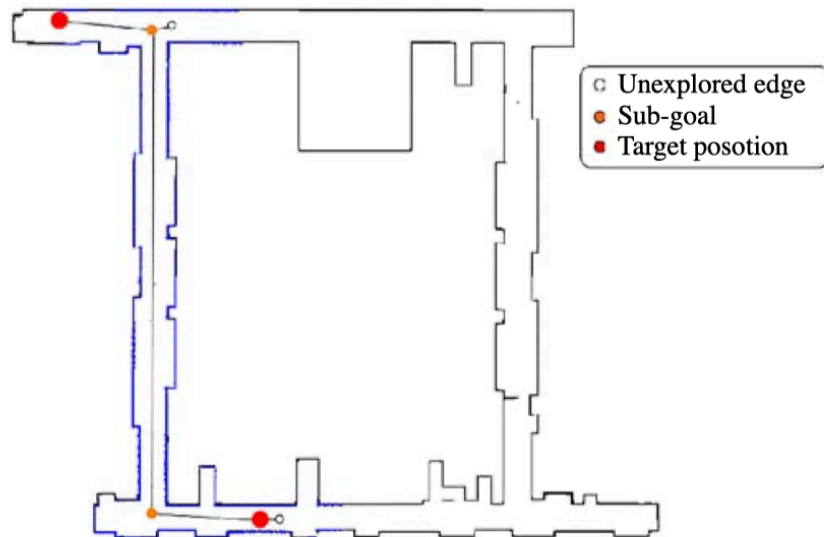
1. Yamamoto’s Sub-Goals and Target Locations Are Not Route Poses

82. Yamamoto’s sub-goals and target locations are not route poses and are not footprints “indicative of poses of the robot along the route.” 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.

83. Sub-goals and target locations also cannot be the claimed “route poses” 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.

84. Additionally, sub-goals and target locations also cannot be the claimed route poses because they are not repositioned in response to any determined repulsive or attractive forces, as also required by Claim 1. Yamamoto never suggests that repulsive/attractive forces can be calculated on a sub-goal or target location, nor that they would be repositioned based on such forces. And indeed, the Petition never argues or suggests that either. *See* Petition at 81-86. Thus, sub-goals and target positions are not route poses or footprints and do not comprise a plurality of points.

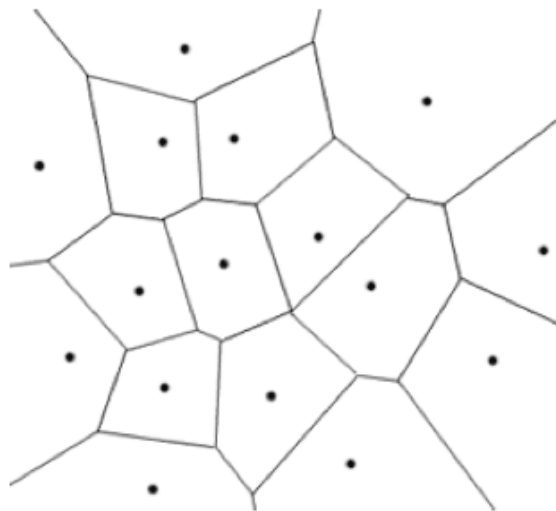
2. Voronoi Edges Are Not Route Poses of a Robot

85. The Petition also argues, without any explanation, that “Voronoi edges” “comprise route poses and footprints indicative of poses of the robot along the route.” Petition at 78. Notably, the Petition and Petitioner’s expert never explain what a Voronoi edge is. But Petitioner apparently believes that a Voronoi edge represents a robot’s position. *See* Petition at 80 (“Yamamoto also discloses that the robot’s position, and therefore Voronoi edges and sub-goals, are modeled using a plurality of points”). That is incorrect. 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 route, pose, or footprint.

86. 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).

87. 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.

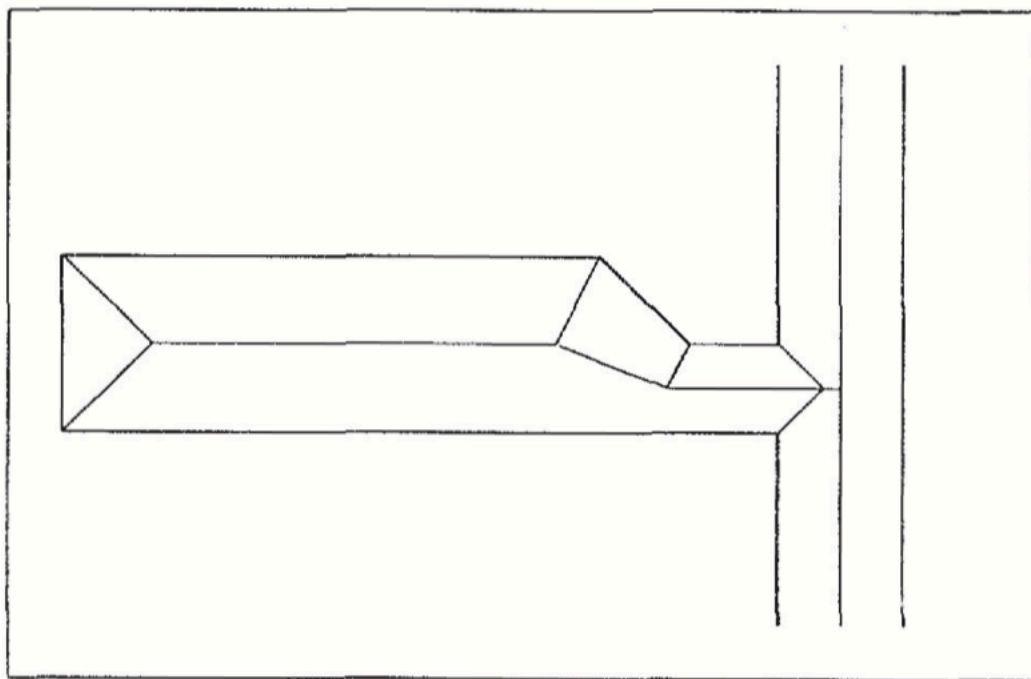


Figure 5: Voronoi Diagram of the Example Map

EX2053 at 124.

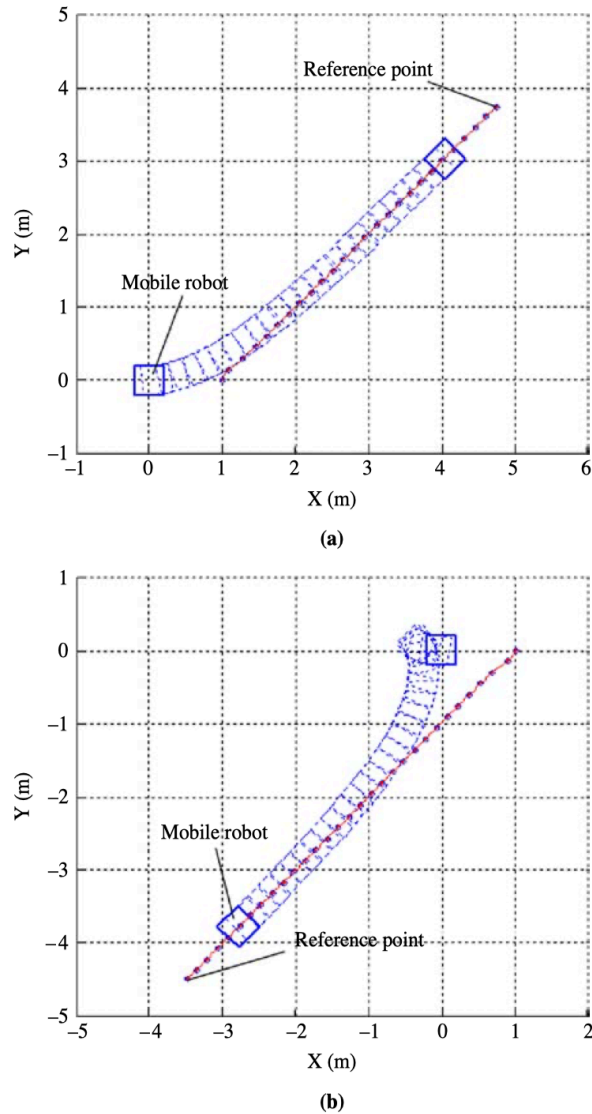
88. Because Voronoi edges are a calculated feature of a map, they are not representations of a robot's route, pose, or footprint. Indeed, a Voronoi edge does not have a footprint and the Petition does not articulate how a Voronoi edge is a footprint indicative of the pose of the robot.

89. Moreover, because Voronoi edges are calculated from the map, they could not be repositioned in response to any forces as required by Limitation 1[b][5]. For example, as shown in Miller's Figure 5 above, a Voronoi edge between two parallel walls would be the line segment halfway between those two walls. The halfway point between two walls would not change based on any forces and the concept does not make sense.

3. A Reference Point Is Not a Route Pose Because It Is a Singular Point

90. Lastly, the Petition also attempts to map Yamamoto's "reference points" to the claimed route poses. Petition at 78. 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. 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 “*each* route pose has a plurality of points disposed therein.” Rather, the Petition

skips reference points entirely when addressing “plurality of points disposed therein.” Petition at 80 (“Yamamoto also discloses that the robot’s position, and therefore Voronoi edges and sub-goals, are modeled using a plurality of points”). Accordingly, Yamamoto’s reference point is not a route pose as claimed.

4. The Petition Fails to Identify a Plurality of Points Disposed in a Route Pose

91. As explained above, none of the sub-goals, target locations, Voronoi edges, and reference points that the Petition mapped as the claimed “route poses” have a plurality of points disposed therein. Nevertheless, the Petition presents two arguments. First, the Petition argues: “Yamamoto discloses that each potential robot position is comprised of a plurality of points because Yamamoto discloses that each position is constructed by collecting a plurality of points of sensory data.” Petition at 80 (citing EX1010, 429). This argument does not make sense because it relies on Yamamoto’s discussion of how a “robot gathers information of its vicinity and creates a finite set P of points which approximates the sensory data from each laser scan” and how “[b]ased on each local scan, the robot accumulates the approximate sensory data for incrementally building an approximate Voronoi structure of its workspace while moving towards a target.” *Id.* (citing EX1010, 429). That disclosure relates to how a robot constructs a *map of the environment* and has nothing to do with a robot’s route or pose, much less how any sub-goal, target location, Voronoi edge, or reference point has a plurality of points disposed therein.

92. Second, the petition argues: “Yamamoto also discloses that the robot’s position, and therefore Voronoi edges and sub-goals, are modeled using a plurality of points because each robot’s position accounts for ‘distance between two driving wheels’ among other physical constraints such the radius of the wheels.” Petition at 80. As discussed above, Voronoi edges are a calculated property of the map of the environment, not a representation of the robot’s position or route. And as also discussed above, sub-goals are singular points and not a plurality of points. But at its core, the argument does not make any sense because the “distance between two driving wheels” and the “radius of the wheels” are dimensions of components of the robot. They are not points on a route pose. Again, the claim requires that forces be calculated on the plurality of points, and it does not make sense—and the Petition never argues—that forces could be calculated on the “distance between two driving wheels” or the “radius of the wheels.” *See* Petition at 81-83.

93. Accordingly, the Petition fails to demonstrate that Yamamoto/Khatib discloses Limitation 1[b][3].

B. The Petition Fails to Demonstrate that Repulsive and/or Attractive Forces Are Calculated on Each of the Plurality of Points of Each Route Pose (Limitation 1[b][4])

94. The Petition fails to demonstrate that the Yamamoto/Khatib combination discloses “determine forces on each of the plurality of points of each route pose, the forces comprising repulsive forces from one or more of the detected

points on the one or more objects and attractive forces from one or more of the plurality of points on others of the one or more route poses.”

95. The Petition relies on equations 12 and 13 from Yamamoto, which the Petition argues calculate attractive forces and repulsive forces. Petition at 81-82. But as the Petition admits, “Yamamoto discloses using the potential field method to calculate forces for *a given reference point.*” *Id.* at 82. As discussed above, a reference point is just a singular point that the robot chases. The Petition never demonstrates how any repulsive or attractive forces are determined on *each* of the *plurality* of points of *each route pose*.

96. Indeed, as mentioned in the preceding section, the Petition made nonsensical arguments that the plurality of points were the “points of sensory data” used in generating a map of the surrounding environment or were the dimensions of the robot like the “radius of the wheels” or the “distance between two driving wheels.” Petition at 80. But the Petition never argues that any forces would be calculated on “points of sensory data” or on the dimensions of the robot’s components.

97. Additionally, the Petition never shows how any attractive forces are from “one or more of the plurality of points on *others* of the one or more route poses,” as recited in Claim 1. Petition at 81. Instead, the equation 12 that the Petition relied upon only is a calculation between the “coordinates of the reference point” and the

“coordinates of the destination,” not any forces from another route pose. EX1010 at Equation 12; Petition at 81.

98. Accordingly, the Yamamoto/Khatib combination does not disclose Limitation 1[b][4].

C. The Petition Fails to Show that Yamamoto/Khatib Repositions Route Poses in Response to Forces (Limitation 1[b][5])

99. Limitation 1[b][5] recites, “reposition one or more route poses in response to the forces on each point of the one or more route poses.” The Petition never argues that any of the things it identified as route poses are ever repositioned in response to forces. Instead, the petition argues that “Yamamoto also discloses *repositioning the robot* based on potential forces.” Petition at 84. The “robot” is not the same as a “route pose.” The Petition never argues that sub-goals, target locations, or Voronoi edges are ever repositioned. Thus, the Petition fails to show that route poses are “reposition[ed] ... in response to the forces on each point of the one or more route poses.”

D. The Petition Fails to Show that Yamamoto/Khatib Discloses “Interpolation Between One or More Route Poses” (Limitation 1[b][6])

100. Limitation 1[b][6] recites, “perform interpolation between one or more route poses to generate a collision-free path between the one or more route poses for the robot to travel.” Yamamoto does not disclose interpolation between one or more route poses. Yamamoto never uses the term “interpolation,” “interpolate,” or any

variation of the term. *See generally* EX1010. Instead, as the Petition admits, Yamamoto discloses, “[t]he system controller (look-ahead control) used in this research is based on *feedback linearization technique* in which linearization is achieved between the control inputs and appropriate outputs.” EX1010, 422; Petition at 86. The Petition argues that “A POSITA would understand that Yamamoto generates the path by interpolating a path between the start and goal positions.” Petition at 86. This is wrong. Feedback linearization and interpolation are different concepts and a POSITA would not have understood Yamamoto to disclose interpolation between one or more route poses. The Petition tries to rely on Figures 5 and 9 of Yamamoto, but nothing in these figures show interpolation. Rather, Figures 5 and 9 show a robot chasing a reference point, not interpolation of new reference points. EX1010 at 424 (“Figure 5(a) and (b) show the experimental results of the trajectory of the mobile robot which moves along a straight line 45 and 225° from a positive X-axis in processing time 25 and 30 s, respectively.”); 426 (“Figure 9(a) and (b) represent the obstacle avoidance path of the mobile robot moving with a large and small look-ahead distance (L), respectively.”). Nothing in Yamamoto suggests that Figures 5 and 9 show interpolation.

101. Accordingly, the Petition fails to show that the Yamamoto/Khatib combination discloses Limitation 1[b][6].

E. The Petition Fails to Demonstrate the Remaining Independent Claims Would Have Been Obvious for the Same Reasons

102. The Petition's Ground 3 arguments for the remaining independent claims, 9 and 18, rely on cross-references to their Claim 1 arguments, with the exception of Limitation 9[b]. *See* Petition at 92-93. Thus, for the same reasons as Claim 1, Ground 3 also does not show that Claims 9 and 18, and thus all claims that depend from Claims 1, 9, and 18, would have been obvious.

103. Also, for Limitation 9[b], Ground 3 refers to its arguments for Limitation 2[a] and [3] and [7] regarding the shape of the robot. *See* Petition at 92. But those arguments do not resolve the Petition's failure to identify how each route pose has a plurality of points disposed therein. Thus, Ground 3 fails to demonstrate Claims 9 and 18 would have been obvious.

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

104. Ground 4 adds Beardsley to Ground 3 and addresses only dependent Claim 8. Petition at 98-99. Because Ground 3 fails to show that Claim 1 would have been obvious, Ground 4 also does not demonstrate that Claim 8 would have been obvious.

X. CONCLUSION

105. As set forth in this Declaration, it is my opinion that Avidbots has failed to demonstrate that any of the challenged claims of the '780 Patent would have been obvious to a POSITA.

XI. RESERVATION OF RIGHTS

106. In this declaration, I have offered opinions that the claims of the '780 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.