

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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Wybotics, Co. Ltd. f/k/a Tianjin Wangyuan  
Environmental Protection and Technology Co., Ltd.,  
Petitioner

v.

Zodiac Pool Systems LLC,  
Patent Owner

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IPR Nos. IPR2026-00158; IPR2026-00159; IPR2026-00160  
U.S. Patent Nos. 11,003,191; 11,262,766; 11,880,207

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**DECLARATION OF DR. HAGEN SCHEMPF  
IN SUPPORT OF PATENT OWNER'S RESPONSE**

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I, Hagen Schempf, declare and state as follows:

**I. Introduction**

1. I am over the age of 18 and am competent to make this Declaration. I have personal knowledge, or have developed knowledge, of the matters set forth herein based upon my education, training, and/or experience. If called upon to do so, I would testify competently thereto.

2. I have been retained by counsel for Patent Owner Zodiac Pool Systems LLC (“Patent Owner” or “Zodiac”) as an expert witness in the above matter. I am submitting this Declaration to address the validity of claims 1–3 in U.S. Patent No. 11,003,191 (“the ’191 Patent”); claims 1–5 in U.S. Patent No. 11,262,766 (“the ’766 Patent”); and claims 1 and 11 of U.S. Patent No. 11,880,207 (“the ’207 Patent”). For the purposes of this Declaration, I have not been asked to opine on any other issues not addressed below.

3. My opinions are based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those identified in this Declaration. I may rely upon these materials, my knowledge and experience, and/or additional materials in forming any necessary opinions. Further, I may also consider additional documents and information to rebut arguments raised by the Petitioner Wybotics, Co. Ltd. f/k/a Tianjin Wangyuan Environmental Protection and Technology Co., Ltd. (“Petitioner” or “Wybotics”). I

reserve any right that I may have to supplement this Declaration if further information becomes available or if I am asked to consider additional information. Furthermore, I reserve any right that I may have to consider and comment on any additional expert statements or testimony of Wybotics's expert(s) in this matter.

4. My analysis of the materials produced in this investigation is ongoing and I will continue to review any new material as it is provided. This Declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

## **II. Background and Qualifications**

5. I received my B.Sc. in Mechanical Engineering from Stevens Institute of Technology in Hoboken, NJ in 1984. My M.Sc. was awarded in 1986 at the Massachusetts Institute of Technology (MIT) in 1986 in the field of Mechanical Engineering, followed by a Ph.D. in 1990 in the field of Mechanical and Oceanographic Engineering, awarded to me jointly by MIT and the Woods Hole Oceanographic Institution (WHOI) in Cambridge, MA and Woods Hole, MA, respectively.

6. During my tenure at MIT and WHOI (1984-1990), I was part of a team that developed deep ocean underwater robots that were used in open-ocean exploration, requiring the application of a combination of mechanical, electrical and

software skills. I developed control systems for underwater robotic platforms and remotely operated vehicles (ROVs), including manipulation systems and their integration with underwater camera systems. The robots developed by the team I was a member of, included the Jason Jr. and Jason ROVs, which were successfully deployed and used in the search and discovery of the British luxury-liner *Titanic* and the WWII German battleship *Bismarck* in the Atlantic Ocean and the archeological recovery and mapping of Roman shipwreck artifacts in the depths of the Mediterranean Sea. I also developed an underwater vehicle system controller for camera-based exterior nuclear submarine hull-inspection used at the US Naval base in Groton, CT which relied on closed-loop underwater navigation and camera-based verification systems.

7. From 1990 to 2010, I held multiple positions as a research faculty member at Carnegie Mellon University's (CMU's) School of Computer Science (SCS) and Robotics Institute (RI), receiving full tenure in 1998. I was also the Director of the Hazardous Robotic Systems Laboratory from 1998 to 2008 which focused on systems in remote and hazardous environments not accessible to, or too dangerous for humans.

8. While at CMU (1990-2008) in my role as research and teaching faculty, I developed multiple industrial automation and robotic systems for factory automation and materials handling as well as mobile robots for use in remote and

hazardous environments, for various government and industrial clients, many of which were patented and also licensed to commercial entities and are still in commercial and government use today. Multiple systems and their designs were developed by myself and my team, with original design-elements still in use today.

9. A few of the systems I led the development of, or participated in as a team-member, that would be of note in this proceedings, included (i) an in-tank submerged crawler-ROV (*Neptune*) used for the inspection of liquid storage tanks containing fluids ranging from water to hydrocarbon explosive compounds (jet-fuel, gasoline, etc.), (ii) a collapsible remotely operated demonstration crawler (*Houdini*) with a mounted manipulation system to allow for material ‘plowing’ and solid debris handling, under up-to fully submerged conditions, for petrochemical and nuclear-waste storage tanks which saw deployment (rebranded as *Pioneer* by our commercial partner) through the Department of Energy (DoE) to apply the technology to remote inspection and cleanup at Reactor No.4 of the Chernobyl Nuclear Power Plant (Russia/Ukraine) and within nuclear waste storage tanks at DoE’s multiple decommissioned nuclear sites (primarily Hanford, WA), (iii) a mobile robot platform (*Tessellator*) used in the maintenance of the space-shuttle heat-shield that used a vision system to detect and maintain heat-shielding tiles on NASA’s orbiters, as well as (iv) several different robotic crawlers used in live gas mains (*Explorer-I/-II*) and oil pipelines (*TIGRE*) to visually navigate and inspect

pipe-joints and walls, using non-destructive evaluation (NDE) sensing technologies to detect wall-thinning, joint-leakage, and repair pipe sections based on visual and NDE sensor feedback.

10. From 2000 to 2010, I also co-founded a robotic startup (Automatika, Inc.), where I served as Chief Scientist, where me and my multiple project-teams developed and licensed technologies to the U.S. military and global energy companies that are still in use today across multiple commercial and government application arenas. Automatika was sold in 2008 to a U.S. subsidiary (QNA, Inc.) of a European Conglomerate (QinetiQ Group, plc), and after staying with the combined new company for 2 years, I returned to CMU to continue as tenured teaching and research faculty at the SCS and the RI.

11. During the 2010 to 2015 period, I founded and served as Director of the country's first Professional Master's Degree in Robotics (MRSD) at CMU, which to date has graduated over 200+ (and counting) Masters students in the field of robotics. I taught courses in Mechanical and Systems Engineering, which combined knowledge and teachings from the fields of mechanical, electrical, and software-engineering, with a specific target on robotics and intelligent systems development. I also established a robotics teaching laboratory, which was used to teach incoming graduate students many of the fundamentals and advanced aspects related to motion-sensing using encoders and resolvers of various types, electrical printed circuit board

(PCB) design involving the use of I/O hardware and software with local microprocessors to collect and process multi-sensory data, the application of vision systems and their use in terrestrial robot navigation, manipulation and bin-picking, while integrating all these elements with robotic platforms with varied mechanical motion-actuation and structural elements, including different types of mobility modes, wireless remote control, and data-processing via on- and off-board elements. Modular design principles as they relate to electronics, software and mechanical hardware, whether structural or dynamic, were a key part of the educational curriculum to ensure future generations of engineers and entrepreneurs learn critical skills related to their eventual fields of expertise.

12. During my 20+ year career in academia I have led dozens of teams of graduate student groups in the development of prototype robotic systems as part of a multi-semester technology commercialization project-course, where students were challenged to conceive and develop commercially viable autonomous robotic prototype demonstration systems that integrated graduate level coursework knowledge in the fields of mechanical- and electrical-engineering and computer science, and computer vision in particular, resulting in dozens of projects in the fields of (a) lawn- and professional sports-field maintenance (mowing, line-painting, etc.) using wheeled robot platforms, (b) aerial agricultural assessment platforms (UAVs) using computer vision and sensing to monitor and assess field crops, and (c) order

fulfillment in e-commerce logistics employing manipulation systems using computer vision for bin-picking and -packing applications.

13. My time in academia and industry overlaps the period of the patents and prior art at issue in this case. I am very well versed in the different technologies and technical elements addressed therein, whether mechanical, electrical or computer-vision based, and thus their maturity level and maturation process over the years relevant in this case. During the time-window in question, I certainly possessed, and was very aware of, the different educational levels and experience of people in the academic and commercial fields covered by the patents and prior art in question.

14. As a participant and team lead of robotic system development teams over more than 25 years, I am also keenly aware of the need for domain-knowledge in at least the four (4) main arenas, namely (i) mechanical, (ii) electrical, (iii) computer science [programming, control, computer-vision, etc.] and (iv) systems integration, in order to successfully develop and field competent robotic systems, as they require multi-disciplinary knowledge and practical experience.

15. It is further worth noting that due to my experience in land- and underwater-based robot system development which included designing, building and fielding real-world systems over a multi-decade period, I have a very good understanding of the technical and application challenges faced in each of these

arenas, particularly as it relates to applying elementary and advanced mechanical/electrical designs, sensors and algorithms to each domain, and the unique challenges and limitations these technologies face in these application domains.

16. As evident from my CV and the number, types, and application domains of the multitude of real-world robot developments I was fortunate enough to be a part of, I have long been aware that while certain technologies might be very well suited for certain domains and environments, their application in a different application domain can bring with it challenges that can take a long time and effort to overcome.

17. I thus feel I am properly qualified to opine on the technical arenas and the technology elements discussed and covered by the patents and prior art that form part of these proceedings, as well as the particulars related to the hypothetical Person of Skill in the Art (POSITA) working in the field of robotics during this particular time-period.

18. I retired from my academic career in 2016 and co-founded a technology consulting company providing services to industrial clients with robotic system needs.

19. I have published extensively and particularly in the field of robotic systems, highlighting my work and expertise in the areas of mechanisms, electrical

design, sensor integration and software systems and the various levels and degrees of integration of these into multiple types of robotic systems across multiple application domains.

20. I have received multiple National Design Merit awards over my career, particularly the R&D National Design Award in 2006, as well as the Design News Awards in 1998 and 2001.

21. I have served as an expert in numerous litigations, including litigations in the field of mobile robots and computer-controlled systems. As part of these litigations I have opined on patents related to (i) industrial robotic painting and material handling systems with integrated electro-mechanical elements under software control with remote communications for setup and configuration, real-time control, monitoring and data-processing, (ii) indoor mobile robots with on-board multi-sensory capabilities used for floor cleaning (vacuuming, mopping, etc.), and (iii) material handling robots used by large shipping companies (UPS, FedEx, etc.) to load/unload trailers that used three-dimensional laser-sensing and vision-systems to detect packages and build models to enable automated package stacking/unloading of over-the-road trailers. I have provided a list of my prior expert witness work in my appended curriculum vitae in Ex. 2031.

22. I am a named inventor on 14 issued U.S. and international patents in the fields of integrated and mobile robotic systems exhibiting various types and

degrees of electro-mechanical as well as software and wireless communication integration. Several of these patents have been licensed and have royalty-bearing terms associated with them. The issued Patents and Titles are listed below:

|                                                                             |                                                                                           |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Robot Surveillance System and Method                                        | U.S. Patent No. 8,738,198                                                                 |
| Gas main robotic inspection system                                          | Canadian Patent No. 2,440,344<br>EP Patent No. EP 1373783 B1<br>U.S. Patent No. 6,917,176 |
| Pipe Inspection and Repair System                                           | U.S. Patent No. 6,820,653                                                                 |
| Conduit Network System                                                      | U.S. Patent No. 6,778,100                                                                 |
| Method and system for moving equipment into and through an underground well | U.S. Patent No. 6,675,888                                                                 |
| Dynamically Steerable Mono Belt Apparatus                                   | U.S. Patent No. 6,517,457<br>Canadian Patent No. 2,339,444                                |
| Method and System for moving equipment into and through a conduit           | U.S. Patent No. 6,454,011                                                                 |
| Method and system for measuring data in a fluid transportation conduit      | U.S. Patent No. 6,241,028                                                                 |
| Collapsible mobile vehicle                                                  | U.S. Patent No. 5,451,135                                                                 |
| Reconfigurable mobile vehicle with magnetic tracks                          | U.S. Patent No. 5,363,935<br>U.S. CIP Patent No. 5,435,405                                |

23. I am being compensated for my work in this case at my standard rate of \$500 per hour in connection with my preparation of this declaration, as well as for

each hour spent providing deposition or testimony. This compensation is not contingent upon my performance, my testimony at deposition or trial, the outcome of this case, or any issues involved in or related to this case. I have no financial interest in this matter.

24. My experience and qualifications are further detailed in my curriculum vitae, which is included in Ex. 2031.

25. A list of my entire deposition and trial testimony activities over the years is also listed on the last page of Ex. 2031.

### **III. Documents and Materials Considered**

26. In preparing my opinions, I have reviewed the '191 Patent (Ex. 1001), the '766 Patent (Ex. 1003), the '207 Patent (Ex. 1005), the declaration of Dr. Charles A. Reinholtz (Ex. 1010) and its cited references of record, and have also reviewed the other documents and materials cited herein and the materials listed below. When citing from these references, all emphasis is added unless otherwise noted.

| <b>Ex.</b>                           | <b>Description</b>                                                                                                                                                                                                               |
|--------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex. 1026<br>(refiled as<br>Ex. 2023) | Jonathan Horgan & Daniel Toal, Computer Vision Applications in the Navigation of Unmanned Underwater Vehicles, IntechOpen (Jan. 1, 2009)                                                                                         |
| Ex. 2024                             | Rafael Garcia, Tudor Nicosevici and Xevi Cufi, On the Way to Solve Lighting Problems in Underwater Imaging, Computer Vision and Robotics Group, IEEE (2002)                                                                      |
| Ex. 2025                             | Raimondo Schettini and Silvia Corchs, Underwater Image Processing: State of the Art of Restoration and Image Enhancement Methods, EURASIP Journal on Advances in Signal Processing Volume 2010, Article ID 746052 (Feb. 2, 2010) |

|          |                                                                                                                                                                                                                                                                                                                                          |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex. 2026 | Evan Ackerman and Erico Guizzo, iRobot Brings Visual Mapping and Navigation to the Roomba 980, IEEE Spectrum (Sept. 16, 2016) available at <a href="https://spectrum.ieee.org/irobot-brings-visual-mapping-and-navigation-to-the-roomba-980">https://spectrum.ieee.org/irobot-brings-visual-mapping-and-navigation-to-the-roomba-980</a> |
| Ex. 2027 | Davidson et al., MonoSLAM: Real-Time Single Camera SLAM, IEEE Transactions on Pattern Analysis and Machine Intelligence (Volume: 29, Issue: 6, June 2007)                                                                                                                                                                                |
| Ex. 2028 | Rachel Metz, The new Roomba uses AI to avoid smearing dog poop all over your house, CNN (Sept. 9, 2021) available at <a href="https://www.cnn.com/2021/09/09/tech/roomba-ai-avoids-dog-poop/index.html">https://www.cnn.com/2021/09/09/tech/roomba-ai-avoids-dog-poop/index.html</a>                                                     |
| Ex. 2029 | Brian Heater, iRobot's new Roomba knows where it's going, TechCrunch (Sept. 5, 2018) available at <a href="https://techcrunch.com/2018/09/05/irobots-new-roomba-knows-where-its-going/">https://techcrunch.com/2018/09/05/irobots-new-roomba-knows-where-its-going/</a>                                                                  |

27. My opinions are also based upon my education, training, research, knowledge, and personal and professional experience. I reserve the right to supplement or amend this Declaration in the event that I hereafter become aware of additional relevant information.

#### **IV. Understanding of Legal Standards**

28. I am not an attorney and have not been asked to offer an opinion on the law. I understand, however, that certain aspects of the law are relevant to my evaluation and opinions set forth herein. I have therefore been informed of and asked to apply the legal principles summarized below.

##### **A. Priority Date**

29. I understand that the “priority date” of a patent is the date on which it is filed. I further understand that a patent may be entitled to the filing date of an

earlier-filed application or foreign patent filing. In this case I am informed that the patent application to which the Challenged Patents claim priority was filed on July 10, 2012, and the Challenged Patents are entitled to a priority date of July 10, 2012.

**B. Burden of Proof**

30. I understand that Wybotics as the Petitioner bears the burden of proof in this proceeding and that that burden is to establish by a preponderance of the evidence that the claims are invalid.

**C. Claim Construction**

31. I understand that the words of a claim are generally given their ordinary and customary meaning, which I understand is the meaning that the term would have to a person of ordinary skill in the art (POSITA) in question at the time of the invention, *i.e.*, as of the effective filing date of the patent application. I understand the person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification and prosecution history. Additionally, I understand other extrinsic evidence external to the patent and prosecution history, such as dictionaries and treatises, may also be useful in determining the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention. I understand that such extrinsic evidence, however, is generally afforded less weight than intrinsic evidence in

determining the meaning of claim terms, and overall is unlikely to result in a reliable interpretation of a patent claim scope unless considered in the context of the intrinsic evidence.

32. I understand that Wybotics has proposed, and Zodiac has not opposed, a claim construction of the claim term “means for moving the vehicle body within the swimming pool.” I understand that the term “means for moving the vehicle body within the swimming pool” is a means-plus-function claim term under 35 U.S.C. § 112(f).

33. I understand that Wybotics has proposed, and Zodiac has not opposed, that the structures and function for this term are as follows:

| <b>Claim Limitation and Claims</b>                                                                                                                                                                     | <b>Corresponding Structures</b>                                                                                                                                                                                                                                                                                                                                                                              | <b>Function</b>                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| “means for moving the vehicle body within the swimming pool”<br><br>’191 Patent claims 1(b), 2(a)(ii), 3(a)(iii)<br><br>’766 Patent claims 1(b), 2(b), 3(b), 4(b), 5(b)<br><br>’207 Patent claims 1(b) | “In one implementation, vehicle 30 is propelled along the submerged pool surface using wheels, rollers, tracks or other surface contacting members powered by a motor and the like. ... In one implementation vehicle 30 may also alternatively be propelled by means of the vacuum or liquid jets. ... In other implementations, vehicle 30 may include other propulsion mechanisms.”<br>Ex. 1001, 3:31–43. | Moving the vehicle body within the swimming pool |

**D. Anticipation Under 35 U.S.C. § 102**

34. I understand that a claim is invalid if the invention recited in the claim would have been anticipated by a prior art disclosure at the time the invention was made. I understand this means that the petitioner must show that each and every requirement or limitation of the claim is found in a single prior art reference and arranged or combined in that reference in the same way as required by the claim. I further understand that in determining if a claim is anticipated, one should take into consideration not only what is expressly disclosed in a particular prior art reference, but also what is inherently present or disclosed in that reference. I understand that prior art inherently anticipates a patent claim if the missing element(s) or feature(s) would necessarily result from what the single item of prior art teaches to a person of ordinary skill in the art. I understand that to be inherent, the element(s) or feature(s) that are alleged to have been inherent must necessarily have existed in or resulted from the prior art reference. The fact that the element(s) or feature(s) are only likely to have existed is not sufficient.

**E. Obviousness Under 35 U.S.C. § 103**

35. I understand that a claim is invalid if the invention recited in the claim would have been obvious to one of ordinary skill in the art at the time the invention was made. I understand this means that even if all the requirements of the claim cannot be found in a single prior art reference that would anticipate the claim, a

person of ordinary skill in the field of the invention knowledgeable of the prior art would have come up with the claimed invention. In considering whether a claim is obvious, I have been asked to consider (a) the level of skill in the art at the time of the claimed invention, (b) the scope and content of the prior art, (c) any differences between the prior art and the claims of the patent-in-suit, and (d) any “secondary factors” tending to show non-obviousness of the claimed invention, including commercial success, long-felt but unresolved need, failure of others, copying, praise by others, unexpected results, and simultaneous invention by others.

36. I understand that a claim composed of several elements is not proven as obvious merely by demonstrating that each of its elements was independently known in the prior art. I also understand that obviousness should not be analyzed using the benefit of hindsight. Instead, it must be analyzed from the standpoint of what was known and understood by a POSITA at the time of the claimed invention. I further understand that demonstrating that a modification to a reference or the combination of multiple references is obvious, requires providing a reason for why a POSITA would modify a reference or combine multiple references and that reason must be supported with some underpinning rationale. Merely pointing out that two references are similar or in the same field of endeavor is not sufficient.

## **F. Secondary Considerations of Non-Obviousness**

37. I understand that in determining whether the claims are obvious I must also consider certain factors that may help determine that a particular concept was not obvious. These include practical factors relating the concept, including (1) commercial success, (2) a long-felt need for a solution to the problem facing the inventors, (3) whether others tried and failed to solve the problem, (4) whether others copied the claimed invention, (5) whether the invention achieved unexpected results, (6) whether the prior art teaches away from combining certain known elements, and (7) whether others in the field praised the invention.

## **V. Level of Ordinary Skill**

38. I understand there is a concept in patent law known as a person having ordinary skill in the art (POSITA). I understand that this concept refers to a person who is trained in the relevant technical field of a patent without possessing extraordinary or otherwise exceptional skill or training. I further understand that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, prior art solutions to those problems, and the speed at which innovations are made may help establish the level of skill in the art.

39. Taking these factors into consideration, it my opinion, with regard to the Challenged Patents, a person of ordinary skill in the art would have a bachelor's

degree in mechanical or electrical engineering or a related field, and two years' experience in designing and developing robotic pool cleaners or similar products, with additional experience substituting for education and vice versa.

40. I understand that Petitioner asserts that a person of ordinary skill in the art would have "a bachelor's degree in mechanical or electrical engineering or a related field, and two years' experience in designing and developing robotic pool cleaners or similar products, with additional experience substituting for education and vice versa." Petition at 7.

41. Based at least on my educational and work experience, I was at least a person of ordinary skill in the art as of the effective filing date of the Challenged Patents (July 10, 2012) under either the Petitioner's proposed definition for a POSITA or my own. And while I note that my qualifications and experience exceed this definition of a person of ordinary skill of the art, in arriving at the conclusions in this Declaration, I have considered the issues from the perspective of a person of ordinary skill of the art at the relevant time.

42. Unless otherwise stated, I have applied this level of ordinary skill in the art for the purposes of this Declaration.

## **VI. Overview of the Challenged Patents**

43. The '191 Patent is entitled "Pool Cleaning System and Method to Automatically Clean Surfaces of a Pool Using Images From a Camera," issued on

May 11, 2021, and names Kameshwar Durvasula and William Londono Correa as co-inventors.

44. The '766 Patent is entitled "Pool Cleaning System and Method to Automatically Clean Surfaces of a Pool Using Images From a Camera," issued on March 1, 2022, and names Kameshwar Durvasula and William Londono Correa as co-inventors. I understand that the '766 Patent is a continuation of the '191 Patent.

45. The '207 Patent is entitled "Pool Cleaning System and Method to Automatically Clean Surfaces of a Pool Using Images From a Camera," issued on January 23, 2024, and names Kameshwar Durvasula and William Londono Correa as co-inventors. I understand that the '207 is a continuation of the '766 Patent.

46. Each of the Challenged Patents share the same Abstract, Figures, Background, Summary of the Invention, Brief Description of the Drawings, and Detailed Description of the Example Embodiments. Because these sections of the Challenged Patents are the same, I have only cited to the '191 Patent in this Overview of the Challenged Patents and the Background of the Technology sections for ease of reference. Where there are any differences, I have noted otherwise by specifically citing to the '766 Patent or the '207 Patent.

47. The Challenged Patents describe systems and methods for automatically cleaning debris from a submerged surface of a swimming pool with a self-propelled pool cleaner. *See* '191 Patent at Abstract. More specifically, the

Challenged Patents describe a way of using a “camera to capture imagery of the pool surface,” “generate a control signal to direct movement of the cleaner” based on the captured image, including so it can clean a portion of the pool surface. ’191 Patent, 1:41–1:46; *see also* ’191 Patent, 1:57–2:3, 2:19–32. The Challenged Patents explain that, at the time the patent they claim priority to was filed, “[m]anually cleaning the floor and sides of a swimming pool may be tedious and time-consuming task,” so “automated robotic pool cleaners [were] developed.” ’191 Patent, 1:23–25. Although named “*automated* robotic pool cleaners,” these prior versions had shortcomings, for example, “controlling and monitoring such automated robotic pool cleaners to insure [sic] that all portions of the pool surfaces are satisfactorily cleaned remains a challenge.” ’191 Patent, 1:26–28. And despite society’s current colloquialism for calling something “automated,” these “*automated* robotic pool cleaners” were nothing like the novel and groundbreaking invention claimed in the Challenged Patents. And to allow such current common use of the words “automated” or “autonomous” to influence the analysis of the Challenged Patents’ claims and the prior art references raised by Wybotics, would result in an impermissible hindsight bias.

48. The Challenged Patents further describe the state of the art, and how the automated robotic pool cleaners at the time functioned and navigated the pool. Specifically, before the Challenged Patents, robotic pool cleaners were designed to

roam a pool at random or merely follow a pre-programmed path, collecting debris randomly encountered in the pool along the way. '191 Patent, 4:56–60.

49. The Challenged Patents overcame these deficiencies and challenges by providing a novel solution of enabling a robotic pool cleaner to be “precisely steered under the control of [a] controller” that “utilizes signal from [a] camera,” allowing “entire summer [sic.] surfaces of [a] pool [to] be more quickly and efficiently covered and cleaned.” '191 Patent, at 4:35–5:7. The efficiencies and improvements made by the inventions claimed in the Challenged Patents were simply not present nor implemented in the prior art.

## **VII. Background of the Technology**

50. As of the priority date of the Challenged Patents (July 10, 2012), the claimed inventions described above were novel and non-obvious.

51. As of July 10, 2012, the priority date of the Challenged Patents, robotic pool cleaners faced numerous limitations and thus operated in a very different manner. As of the July 10, 2012, priority date, robotic pool cleaners relied on what we now know to be inefficient methods of cleaning a pool. Robot pool cleaners navigated the surfaces of a pool by either (1) roaming a pool-surface at random, or (2) following a pre-programmed path. '191 Patent, 4:56–60. The robotic pool cleaner would then simply collect debris it randomly encountered in the pool along its random or pre-programmed path(s). '191 Patent, 4:56–60. These methods of

cleaning were constrained by hardware limitations and the inability to reliably integrate imaging developments found in other application-environments to drive innovation. As I discuss below, at the time of the priority date of the Challenged Patents, the field of underwater camera-based imaging for the purposes of navigation and feature-recognition, was far from being fully developed, let alone commercially available. And underwater imaging and robotics applications presented unique problems that were not present in imaging or robotics in terrestrial or above-water environments. It wasn't until the claimed inventions in the '191 Patent that a more efficient cleaning operation was conceived.

**A. Hardware Limitations in Robotic Pool Cleaners as of July 2012 Limited Their Efficiency and Effectiveness.**

52. The Challenged Patents identify a practical limitation of prior automated robotic pool cleaners. Although such cleaners had been developed, “controlling and monitoring” them to ensure that all of the pool surfaces were satisfactorily cleaned remained a challenge. '191 Patent, 1:24–28. Without the claimed camera-based control, a vehicle may cover or travel across pool surfaces either randomly or according to an automated coverage algorithm or stored coverage pattern. '191 Patent, 4:56–60. In either of those modes of operation, the cleaner may (i) miss portions of the pool, (ii) pass over areas without cleaning them satisfactorily, or (iii) re-clean a portion already cleaned or not needing any additional cleaning, requiring human intervention with additional later verification and re-cleaning.

53. The hardware environment also placed practical limits on what robotic pool cleaners could do. The SubjuGator 2011 paper, which Dr. Reinholtz cites, describes a research AUV (Autonomous Underwater Vehicle) with a proposed vision system that demonstrates that underwater vision-based control at the time actually required significant supporting hardware and software in order to just attempt to overcome challenges faced in underwater imaging. Ex. 1017, 1. Specifically, the paper states that “[b]ecause underwater environments can pose many types of challenges for object identification such as varying luminosities, sunlight dissipation, particle noise, and occlusions, combinations of novel normalization, filtering techniques and color space models are developed to robustly extract relevant target information from the environment in real-time.” Ex. 1017, 7. The architectural complexity required for the AUV developed in the publication underscores the limitations imposed by the hardware on robotic pool cleaners in July 2012, and emphasizes why it would be an oversimplification to assume that any terrestrial robotic cleaner with a camera could be adapted into an efficient camera-controlled robotic pool cleaner. The computer-imaging results depicted in the paper also make clear that object detection and identification was successful because the target objects (buoys and pipes) were pre-configured in the experiment as highly contrasting (color and intensity) objects when compared to the image background—these are highly simplistic ‘environment-rigging’ steps for the purpose of ensuring

experimental success, that a real-world environment would simply not exhibit, calling the successful application of these techniques to debris-detection by underwater pool cleaning robots into question.

54. The limitations were not merely optical. In addition to intelligent navigation, underwater robotic pool cleaners also needed to address buoyancy, traction, hydrodynamic forces, water-flow resistance, debris transport (and dispersion/disturbance) in a liquid medium, debris retention, and reliable surface contact on pool floors and walls. The '191 patent describes vehicle propulsion along submerged surfaces using surface-contacting members, vacuum-aided surface-adhesion and -propulsion, or liquid jets, and it explains that the vacuum or liquid jets used for propulsion also facilitate loosening debris for collection. '191 Patent, 3:20–43. The patent's exemplary pool-cleaning vehicle also includes a self-contained onboard filtration system and the ability to include a chemical dispenser to apply pool cleaning chemicals to the surfaces of the pool. '191 Patent, 3:4–23. Those disclosures show that robotic pool-cleaner hardware had to integrate mobility, surface-adhesion and -traction, fluid handling, and cleaning functions in a submerged environment on a singular platform.

55. Moreover, communication with the robotic pool cleaner presented challenges due to hardware limitations. Wireless communication via radio-waves, such as over Wi-Fi and Bluetooth, and infrared waves are well known to not work

underwater, so communicating with, and direct control of, a robot is not readily achievable, unless the system is attached via a cable to a remote controller, thereby providing a communication link and potentially even uninterrupted power. Hence teleoperation or even remote real-time closed-loop position-based control presents tremendous challenges in any attempt at automating pool-cleaning devices. While there are possible ways around the communication and power bottlenecks, they bring with them installation and operational challenges that would not necessarily result in a commercially viable and successful implementation, and certainly would not exhibit and incorporate the advanced capabilities as those described in the Challenged Patents.

56. The field of underwater camera-based imaging for the purposes of navigation and feature-recognition, -identification, -tracking, and navigation were, at the time of the priority date of the Challenged Patents, far from being fully developed, let alone commercially available. Any use of underwater cameras required specialized hardware and software applied to a particular narrow task and even then, could readily fail unless conditions were ideal and would only work reliably when humans had provided rigged and/or assistive features, or specified favorable operational conditions, to ensure maximal operational reliability.

**B. As of July 2012, Underwater Imaging Presented Problems and Required Solutions Not Present in Terrestrial Imaging.**

57. As of July 2012, automated robotic pool cleaners were specialized devices operating in an environment very different from terrestrial floor cleaners or general-purpose mobile robots. The underwater operating context created issues that were not of concern for ordinary terrestrial robots. A 2008 survey-paper provided a review of computer vision for unmanned underwater vehicles and explained that “[t]he characteristics of the underwater environment pose a plethora of difficult challenges for vehicle navigation and these obstacles differ greatly from the issues encountered in land, air and space based navigation” for a multitude of reasons, including that water attenuates acoustic and electromagnetic radiation, limits communication bandwidth, and creates currents, waves, and pressure-related design constraints. Ex. 1026, 195 (refiled as Ex. 2023, 195). The same review paper further explained that underwater vehicles generally need onboard computation because communication bandwidth is limited, and that underwater navigation sensors must be selected based on factors such as resolution, update rate, cost, calibration time, depth rating, range, power requirements, and mission objectives. Ex. 1026, 195–196 (refiled as Ex. 2023, 195–196). Those considerations are far more involved than the technical constraints underlying ordinary floor-cleaning robots operating in air on dry surfaces.

58. Optical imaging in water was also materially different from optical sensing in air. Water is approximately 800 times denser than air. The underwater-vehicle vision review paper explained that underwater optical imaging is not carried out in an ideal environment because image quality is affected by lack of distinguishable seafloor (*i.e.*, submerged surface) features, the need for artificial light, water clarity, turbidity, depth, surface conditions, scattering, attenuation, image distortion, and image-processing limitations. Ex. 1026, 197 (refiled as Ex. 2023, 197). It explained that “backscatter can result in bright specs appearing on the images, sometimes referred to as marine snow, while also affecting image contrast and the ability to extract features during image processing.” Ex. 1026, 197 (refiled as Ex. 2023, 197). And “[f]orward scatter occurs when the light from the light source is deflected from its original path by a small angle,” which “can result in reduced image contrast and blurring of object edges. Ex. 1026, 197 (refiled as Ex. 2023, 197). It also explained that absorption and attenuation reduce the effective range of underwater vision systems and that refraction at water/glass and glass/air interfaces can produce non-linear image deformation requiring calibration. Ex. 1026, 197 (refiled as Ex. 2023, 197).

59. Note further that the examples provided in this survey paper are related to deeper-water applications, where surface lighting effects are not as relevant as in the swimming pool context. This matters greatly as a combination of (wind- or

human-induced) surface ripple, floating debris, variable sun-orientation and cloud-cover outdoors, coupled with uncontrollable illumination will cast time-varying dynamic and unpredictable shadowing that would have to be discerned from actual underwater features and debris.

60. Contemporary publications further highlighted that underwater image processing remained a challenging and nascent area of research, not a plug-and-play function as Wybotics and Dr. Reinholtz contend. For example, the 2002 review article “On the Way to Solve Lighting Problems in Underwater Imaging” by Garcia et al. described absorption and scattering as “transmission properties of the medium [that] generate some problems in underwater images, such as blurring of image features, limited range, clutter and lack of structure in the regions of interest.” Ex. 2024, 1018.

61. This Garcia reference, deals primarily and exclusively with the issues of robot-mounted illumination conditions and sun-wave illumination interactions for the purposes of maximizing contrast and object/surface illumination in simulated deep and shallow water conditions. It details the use of homomorphic filtering coupled with a tailored illumination-reflectance model, and compares experimental results for different lighting-correction strategies. While yielding some success, the experimental results are extremely sensitive to light-source type and location. Minimal to direct sun-light illumination required different approaches, including

manual selection of imaging parameters, but still was unable to correct adequately for water-surface disturbances (waves from wind, water-flow, etc.), which is a well-known occurrence in any swimming pool, which a POSITA would have understood to require yet another level of algorithmic and operational complexity within a pool-floor cleaner's imaging system. The conclusions section goes even further by referencing shallow water image testing, with the authors stating that "[t]his type of imagery presents a higher degree of difficulty", as "sun rays are refracted by the waves and image irradiance is irregularly concentrated in small areas of the image, and changes are evident from one image to the next." Ex. 2024, 1023. The authors clearly identify that "[i]n this case results are not so satisfactory, but still promising...", leading any POSITA to consider this an incomplete solution and further question the chance of success for such an implementation, even if it were to be developed further. The paper also describes addressing the "[p]resence of small 3D relief ... having only been "timidly tested." (Ex. 2024, 1023), which a POSITA would recognize as the need for addressing shadowing due to uncontrollable and variable location and intensity of pool-external light-sources (sun, perimeter-lights, etc.) and their effects on submerged pool-surface shadows generated by pool-edges, pool-external structures, environmental conditions, and floating debris/toys, etc., which unlike in the paper's experimental setup do vary unpredictably, further

increasing the uncertainty of a successful application to a swimming-pool cleaner under real-world conditions.

62. Overall, the Garcia paper clearly highlights a subset of the complexities faced in shallow water computer vision applications due to dynamically variable illumination and shadowing, and even states that future research and experimentation and investigation would be needed, like “... searching for a model ...” and “... more extensive experimentation should be performed...” and “... a methodology ... of the performance ... should be investigated...”, to account for these and other factors. Ex. 2024, 1023. This would give any POSITA substantial pause about the necessary technical effort to arrive at a successful implementation.

63. Similarly, “Underwater Image Processing: State of the Art of Restoration and Image Enhancement Methods” by Schettini and Corchs, provides a survey of the research up until 2010 in the areas of image restoration and enhancement to improve on object-detection, -identification, and -classification. This reference explained that the “[p]hysical properties of the [underwater] medium cause degradation effects not present in normal images taken in air.” Ex. 2025, 1. Further, “[u]nderwater images are essentially characterized by their poor visibility because light is exponentially attenuated as it travels in the water and the scenes result poorly contrasted and hazy.” Ex. 2025, 1. Thus, “absorption and scattering

processes of the light in water influence the overall performance of underwater imaging systems.” Ex. 2025, 1.

64. Critically, as of 2010, “[t]he difficulty associated with obtaining visibility of objects at long or short distance in underwater scenes presents a challenge to the image processing community.” Ex. 2025, 12. And, despite an understanding of the algorithmic model(s) of light propagation in water (Ex. 2025, Sec.2, 2-4), utility of images due to lighting-constraints is still susceptible to location of camera and any lighting source, which we know is not always a predictable condition, particularly for outdoor swimming pools. Image restoration presents an even more challenging step, as prior work required the use of training data in the form of copious images or videos, or even measuring actual water properties in situ, in order to tune the parameters needed for improving an image for the purposes of feature restoration – a step any POSITA would have understood to be prohibitive and unrealistic to cover the myriad number and types of indoor-/outdoor-pool setups and configurations (Ex. 2025, Sec.3, 4-6). Image enhancement and the associated color correction are important steps even for shallow water environments, where water absorbs different wavelengths with increasing depth, eliminating reds below 3 meters, oranges below 5 meters, and yellows below 10 meters of depth (Ex. 2025, Sec.4, 6), resulting in blue-green and non-uniformly colored images. Color-correction is thus an important step in object-detection and -identification which will

vary based on depth and lighting conditions, which this paper also identifies as a field of active research, and references Garcia's work, which was addressed earlier.

65. The Schettini and Corchs survey paper, while discussing a wide number of underwater imaging techniques, nevertheless concludes that “[e]ven if numerous approaches for image enhancements are available, they are mainly limited to ordinary images and few approaches have been specifically developed for underwater images.” Ex. 2025, 12.

66. More importantly, it also clearly states that in order to improve on “underwater imaging processing, a common suitable database of test images for different imaging conditions ... is still required.” Ex. 2025, 12. This highlights that existing underwater imaging algorithms were still not robust enough at that time, particularly for shallow water applications and thus not offering a guarantee of achieving the necessary levels of performance, requiring additional testing and evaluation, implying that a successful implementation was not necessarily guaranteed.

67. A POSITA attempting the development and application of a land-based debris-detection feature onto an underwater application domain would have very rapidly become aware of the complexity, failure-modes and the utterly slim chances of success, especially since the underwater environment presents its own environmental application challenges to computer vision in real-world

environments, which are radically different to those encountered in shallow water (whether indoor or outdoor) pool environments. The references cited by Dr. Reinholtz can be recognized as having limited applicability to debris-cleaning operations, which also highlights that the experimental results related therein were primarily achievable in the described experimental setup, by using favorably-configured ‘environments’ and ‘targets’ in an attempt to ensure a particular set of imaging techniques had a chance at reliable operation.

68. Despite the challenges presented in an underwater environment that were not present for ordinary terrestrial robots, it is worth noting that even commercially available robotic vacuum cleaners in dry terrestrial environments, like the iRobot Roomba, did not use cameras for navigation, and certainly not obstacle detection, albeit with severe limitations, until well after the priority date.

69. For instance, iRobot, an undisputed technical leader in commercial indoor floor cleaners at that time, had only released a camera-based floor cleaner (Roomba 980) in September 2015 with any form of imaging capability, which is well past the priority date of the Challenged Patents. Ex. 2026. And the Roomba 980 imaging capabilities were limited to mapping, not debris detection. Ex. 2026. Specifically, the Roomba 980 platform only had a camera pointed forwards and upwards (by 45 deg) in order to image larger indoor features (furniture, doorway frames, ceiling corners and lights, etc.) in order to implement a vision-based

simultaneous localization and mapping (vSLAM) technique to allow the cleaner to self-locate and build a usable map of the indoor areas being/to-be cleaned. Ex. 2026. The camera was never pointed at the floor and was not intended to view nor capable of detecting debris, both physically and algorithmically. Ex. 2026.

70. It is further very telling that the Roomba's non-floor 'obstacle-detection' capabilities were targeted at indoor structure-detection and identification algorithms reliant on the three-dimensional simultaneous localization and mapping capabilities provided through computer vision (vSLAM), whereby the use of a single camera capable of performing vSLAM was not officially published until 2007. Ex. 2027. This is a further indication that it took the industry-leading experts at iRobot an additional eight (8) years to develop and market the capability of terrestrial indoor non-floor-imaging cleaning-apparatus navigation relying on a monocular vSLAM implementation, a fact indicating that a mere POSITA as stipulated by Dr. Reinholtz would have not been assured a reasonable chance of such a successful development for a combination onto an underwater pool cleaning robot.

71. Furthermore, real-time floor-located obstacle and 'object' detection capability in a leading floor-cleaning system would not become officially available until 9 years after the priority date on iRobot's j7/j7+/Combo-j7+ line of floor cleaners/sweepers with their 2021 release (Ex. 2028) of their PrecisionVision Navigation software upgrade to their iAdapt 3.0 Nav package which had been

released in 2018 (Ex. 2029) on the Roomba i7/i7+, but again only addressed navigation and vSLAM for locating and controlling position of the cleaner, without any inherent debris-locating or decision-making features or capabilities. As a matter of fact, the j7-line of floor cleaners did have a forward & floor-facing camera, but was initially exclusively trained on thousands of images of extension cords and pet waste, in order for such common objects to become recognizable and identifiable to an on-board computer vision system, which had computational powers far exceeding those available on the priority date (by 50x or more). The above timeline and implementation complexities again underscore the sheer technical challenge to the industry-leading experts at iRobot, not to speak of the POSITA as suggested by Dr. Reinholtz. And note again, that the ‘obstacle’ detection feature on the 2021-released iRobot’s J7/J7+ was limited to obstacles that would hinder cleaner-progress (extension cord hang-up due to high-centering), or avoid a disastrous post-cleaning situation (namely unknowingly spreading floor-located pet-waste across the floor resulting in a ‘pooptastrophe’) only.

72. In summary, the historical evidence outlined above shows that the very company-assignee of the Schnittman reference (Ex. 1008), namely iRobot, (i) never provided the capability of debris-detection commercially to this day on its line of floor-cleaning robots, (ii) only developed and released an image-based environment-feature detection (with a forwards and upwards facing camera and not aimed at the

floor) capability in 2018, and (ii) even to this day only provides improvement on the vision software for their 2018 release to identify a limited and specific set of obstacles while allowing for global map-building to improve cleaning coverage and -speed/-efficiency as late as 2021. This points to the complexity of even detecting, classifying, and tracking debris in a terrestrial indoor environment, not to speak of the challenges a POSITA would face attempting to apply these to an even more complicated underwater environment.

**C. The Claimed Inventions of the Challenged Patents Provided a More Efficient Cleaning Operation by Robotic Pool Cleaners.**

73. The hardware and software limitations and the challenges that the underwater environment presented mattered, because efficient cleaning required a robotic pool cleaner that had not yet been developed before the priority date of the Challenged Patents. An efficient robotic pool cleaner needed to know which submerged portions had been cleaned, which portions had been missed, and which portions had not been cleaned to a satisfactory degree. And then the robotic pool cleaner had to act based on that determination, moving toward areas that required additional cleaning and away from areas that were sufficiently clean or obstacles that would hinder the robotic pool cleaner's ability to fully clean the pool surfaces. This all had to be accomplished without human oversight or input throughout the entire cleaning process. As such, prior approaches that relied on random movement or

predetermined coverage patterns failed to meet the same level of efficiency provided by the inventions claimed in the Challenged Patents.

74. The claimed inventions of the Challenged Patents solve the problems above by (i) utilizing underwater camera-based imaging systems within an integrated system, (ii) allowing for the ability of employing a pre-planned pool-surface coverage algorithm for debris removal, while (iii) also allowing for the coverage to be updated and modified via on-board computer-vision hardware and software, (iv) with said computer-vision hardware and software capable of identifying areas of uncleaned or incompletely cleaned surfaces at any point during the debris cleaning process and creating a three-dimensional map of the cleaning status and surface-cleanliness, (v) ensuring the pool surfaces it was tasked to clean, would indeed meet a cleanliness characteristic/threshold well superior to those other robotic pool cleaners had been able to achieve at that time, as its capabilities did not simply rely on a single pass along a pre-computed trajectory, regardless of the cleaning method or intensity, as it was capable of re-cleaning any part of the pool surface based on its continuous imaging, measuring, mapping and categorizing of the pool surface cleanliness status, and (vi) account for obstacles in the cleaning path so that it may avoid those by moving away from the object identified by the camera.

75. Any area or location within the pool surface that is, or was, traversed by the pool robot, is continuously analyzed and its cleanliness measure updated

within the computer's representation of the surface-cleanliness-map to allow the robotic pool cleaner to make controller decisions on the path to be taken (deciding on whether to retake a prior path or plan and execute a new path) to ensure the **entire** underwater pool surface it was tasked to clean, meets the pre-determined cleanliness characteristic/threshold.

76. The Challenged Patents further provided improved efficiency by incorporating a chemical dispenser in the automatic robotic pool cleaner. Specifically, “[t]o assist in the loosening of debris, in one implementation, vehicle 30 may additionally include a chemical dispenser to closely apply pool cleaning chemicals to the pool surfaces as the vehicle 30 traverses such surfaces.” ’191 Patent, 3:20–23.

77. Additionally, the Challenged Patents included a more efficient means of collecting the debris it cleaned from the submerged surface of the pool—the debris would be vacuumed from the pool and retained in the filter itself. ’191 Patent, 1:37–39, 3:9–14, 10:18–21. As one example of this, the Challenged Patents describe the filter that retains debris as a “filter bag.” ’191 Patent, 10:18–21.

78. These technology elements and the resulting system capabilities were not offered by robotic pool cleaner manufacturers at the time of the invention.

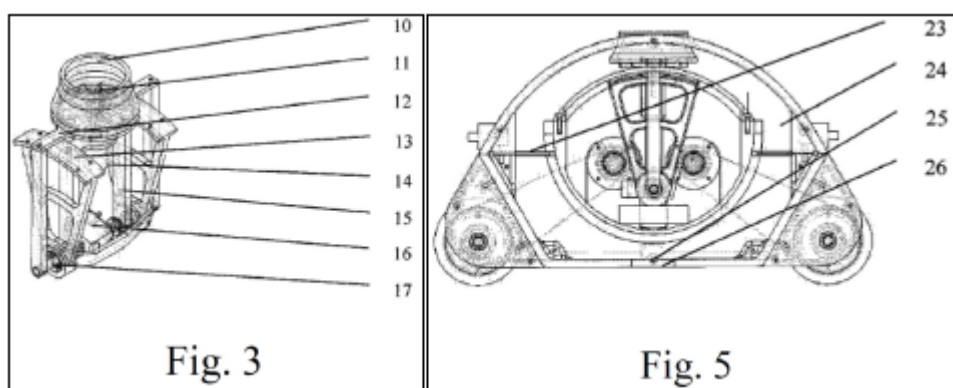
## VIII. The Claims Were Not Anticipated or Obvious

### A. Fu does not disclose “a filter configured to retain debris collected from the submerged surface.”

79. Claim 1–3 of the '191 Patent, claims 1–5 of the '766 Patent, and claim 1 of the '207 Patent require “a filter configured to retain debris collected from the submerged surface.”

80. The Petitions and Dr. Reinholtz assert that “*the filter screen 23* of Fu’s drainage mechanism [is] configured to retain debris collected from the submerged surface.” ’766 Patent Petition at 15 (emphasis added); *see also* Ex. 1010, ¶¶ 141, 239, 374, ’191 Patent Petition at 19–20, ’207 Patent Petition at 14. I disagree.

81. The filter of Fu’s drainage mechanism is merely a screen and is unable to retain debris. Fu describes a “drainage mechanism compris[ing] a water discharger, a water flow channel 24 formed by the driving and control sealed housing and the inner wall of the robot housing, a water flow filter screen 23, and a water inlet with an anti-backflow device 25.” Ex. 1007, [0024]. Figures 3 and 5 of Fu, which I have reproduced below, illustrate each of these distinct parts Fu’s drainage mechanism.



82. Figure 3 is a schematic diagram of the “water discharger, wherein 10 – water outlet, 11 – drainage propeller, 12 – water outlet bracket, 13 – water outlet mounting frame, 14 – drainage propeller high-speed DC motor, 15 – drainage propeller bracket, 16 – water outlet driving servo, 17 – water outlet driving shaft.” All are part of the assembly depicted in said Figure 3. Ex. 1007, [0016]. And Figure 5 is a schematic diagram of the “23 – water flow filter screen, 24 – water follow channel, 25 – anti-backflow device, 26 – water inlet.” Ex. 1007, [0018].

83. Notably, a filter is not shown in Figure 3, nor does Fu’s specification indicate that the “water discharger” includes a filter or that it is configured to retain debris. And nothing in Figure 5 indicates that the filter screen 24 is configured to retain debris. Moreover, all references to a “filter” in the Fu reference indicate that the filter screen is configured to simply “filter out debris” but not retain it. Ex. 1007, [0026]. Instead, it is the anti-backflow device 25, coupled with the shell-walls formed by the inner and outer walls of the water flow channel 24, that prevents debris from flowing out of the water flow channel 24 and out of the robot (and back into

the pool), not the filter. And it is only “[w]hen the water flow stops,” that the anti-backflow device will engage and “close[] due to the absence of water force, which prevents debris from flowing out of the water flow channel 24.” Ex. 1007, [0026]. I have annotated Figure 5 of Fu below to illustrate this.

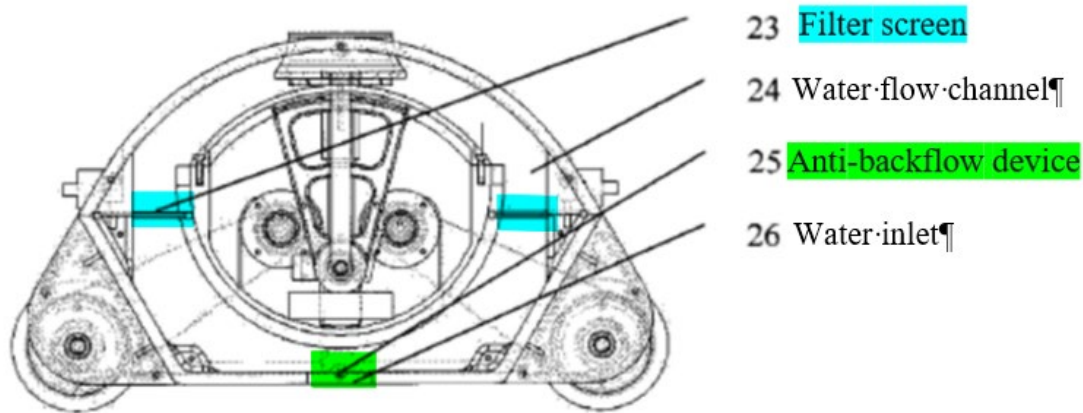


Fig. 5

84. A POSITA would therefore have understood that Fu describes a filter screen that merely allows water to pass through it, while blocking debris, but the filter screen does not to retain any debris collected from the submerged surface.

85. Petitioner and Dr. Reinholtz conflate the anti-backflow device and the water flow channel with the “*filter* configured to retain debris collected from the submerged surface.” As I have stated above, a POSITA would have understood that the filter screen of Fu is not configured to retain debris, but merely to allow water, and not debris, to pass through it. But the filter does not “*retain*” debris, and it cannot do so because it is only a “filter *screen*.”

86. Just as I have described above, the Petitions and Dr. Reinholtz describe this very shortcoming in Fu, and therefore likely recognize it, by stating that “debris that is filtered out by the filter screen 23 is *retained within the water flow channel 24.*” Ex. 1010, ¶ 140 (emphasis added). But the Petitions and Dr. Reinholtz do not address this deficiency—instead they simply ignore it. The Petitions and Dr. Reinholtz explain that the debris is retained in the water flow channel and not the filter, but then miraculously conclude that it is the filter screen 23 that retains the debris.

87. Thus, in my opinion, the Petitions and Dr. Reinholtz fail to establish that Fu discloses “a filter configured to retain debris collected from the submerged surface.”

**B. Fu does not disclose or render obvious, either alone or in combination with Benzler and/or Hui, “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”**

88. Claim 1–3 of the ’191 Patent, claim 1–5 of the ’766 Patent, and claim 1 of the ’207 Patent require “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”

**1) Fu does not disclose “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool**

**to, or away from, the first portion of the submerged surface.”**

89. The Petitions and Dr. Reinholtz assert that “[t]he monitoring cameras 2 and the image acquisition card constitute the environmental perception layer of the control system,” which “is expressly identified as the basis upon which ‘control signals are generated by the central processor ... to drive the robot[]’ in the autonomous mode.” Ex. 1010, ¶ 149; *see also* Ex. 1010, ¶¶ 248, 382; ’191 Patent Petition at 23–26; ’766 Patent Petition at 19; ’207 Patent Petition at 17. I disagree.

90. A POSITA would have understood Fu to describe an underwater cleaning robot that performs a pre-set cleaning path, not a “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”

91. The difference between Fu’s disclosure and the invention in the Challenged Patents is critical because it represents the novel and groundbreaking nature of the invention in the Challenged Patents that a POSITA would have understood as a significant advancement in technology. Indeed, Fu’s autonomous cleaning mode is akin to the methods that robotic pool cleaners used prior to the invention claimed in the Challenged Patents. Particularly, the method of following a pre-programmed path—a method that the Challenged Patents describe as inferior

to its invention because it required “complex steering algorithms or codes” that increases “complexity and cost of [the] system.” ’191 Patent, 4:49–55.

92. The claim language of the Challenged Patents ties three concepts together: (1) the camera capturing an image of “at least a first portion of the submerged surface”; (2) the controller generating a control signal “in response to the captured image”; and (3) said control signal causing movement of the body “to, or away from,” that first portion. Thus, the claims do not merely require that a robot have a camera somewhere in its control system or that the robot simply move after some image information is processed. Rather, the claims require a control signal that is generated in response to the captured image and then causes a directional movement of the body to or away from the imaged portion of the submerged surface.

93. The specification of the Challenged Patents is consistent with that understanding. For example, the Challenged Patents describe a controller configured to generate control signals for steering a vehicle based on signals received from cameras, and explain that the controller may use camera signals to identify missed or insufficiently cleaned portions of the pool surface and steer the vehicle over those portions. The Challenged Patents also describe a method in which cameras capture images of the pool cleaning process, the controller identifying portions of the pool surface that have not been satisfactorily cleaned, and the controller then generating control signals steering the vehicle to re-clean those portions. In that description, the

camera-images are used to continuously image and identify a portion of the submerged pool surface, whether clean or insufficiently cleaned, with the generated control signal steering the cleaner to, or away from, that identified uncleaned or insufficiently cleaned portion.

94. Fu describes a different control architecture. Fu states that its control system includes, among other components, a central processor, monitoring cameras, an image acquisition card, inertial navigation components, motor drivers, cleaning driving wheel DC motors, and a control system box. Ex. 1007, [0024]. Fu further states that the monitoring cameras and image acquisition card form an “environmental perception layer,” while “inertial *navigation components*” form a *separate* “self-attitude and positioning layer.” Ex. 1007, [0024] (emphasis added). As shown in Figure 6, which I have reproduced and annotated below, the camera and image acquisition card, highlighted in blue, are a *separate* input from the inertial *navigation* component, highlighted in green, into the Central Processor. Ex. 1007, Fig. 6.

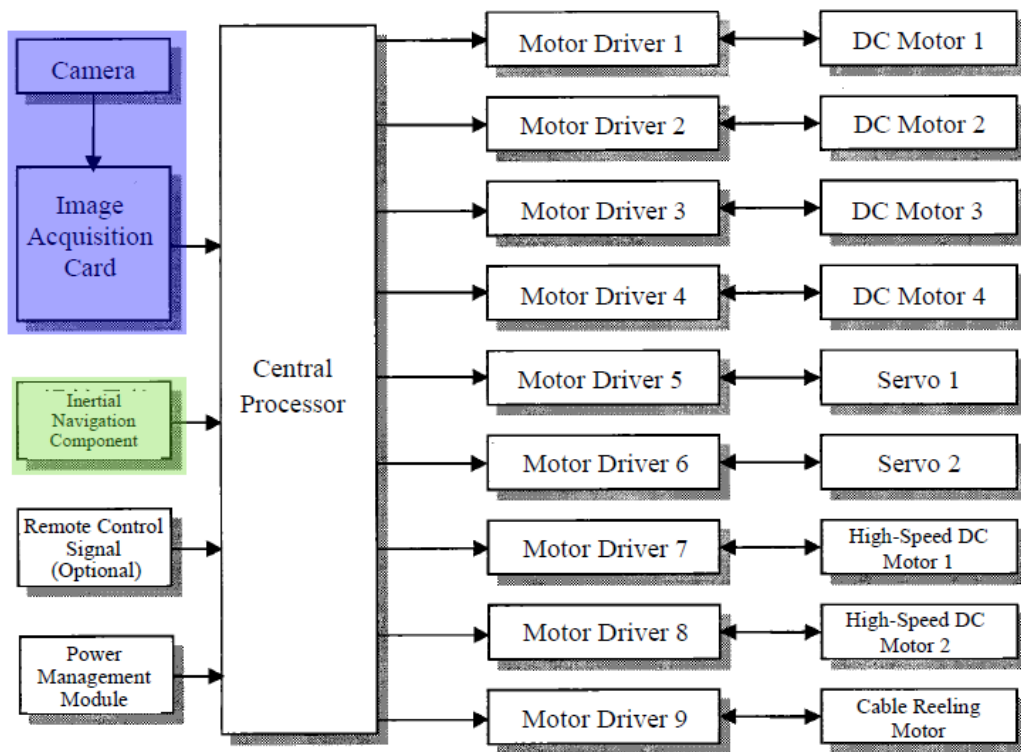


Fig. 6

95. Fu states that “[i]n said autonomous mode, control signals are generated by the central processor, which autonomously plans paths and actions based on information from the environmental perception layer and its own attitude and positioning layer, in conjunction with a preset cleaning task, to drive the robot’s execution layer and complete the underwater cleaning task.” Ex. 1007, [0025] (emphasis added). That portion of Fu’s specification does not describe a control signal that causes movement of the robot body to, or away from, the specific portion of the submerged surface captured in an image.

96. Fu's discussion of image processing also does not supply the missing disclosure. Fu states that, during autonomous cleaning, "a pool cleanliness image threshold is set," and that the robot uses monitoring cameras to capture images of the pool floor, and that the robot compares those images with the threshold to determine a "level of cleanliness." Ex. 1007, [0026]. Fu then states that the robot "plans its cleaning movements" and "adjusts the working state" of the four cleaning driving wheels and the water discharger to complete the cleaning task. Ex. 1007, [0026]. But Fu (i) does not state that the pictured portion is identified as a target location, (ii) does not state that the robot determines the spatial relationship between the robot itself and that pictured portion (a capability evidenced in the Challenged Patents by the system's ability to generate a three-dimensional cleanliness map), and (iii) does not state that the central processor generates a control signal to move the robot toward or away from that pictured portion.

97. Instead, Fu's robot uses the determined level of cleanliness to vary the intensity of the cleaning only. Ex. 1007, [0026]. As to "plan[ning] its cleaning movements and adjust[ing] the working state of the four cleaning driving wheels 3 and the water discharger to complete the cleaning task," Fu states that "[s]pecifically, the speed of each wheel 3 can be adjusted." Ex. 1007, [0026]. "By using different combinations of wheel speeds, cleaning actions of varying intensity can be achieved." Ex. 1007, [0026]. Thus, Fu never states that the planning of cleaning

movements and adjusting of the working state of the driving wheels is to move to, or away from, debris, but **only** addressing the type and ensuing level of cleaning intensity afforded it by the driving wheels' (relative) speed and water discharger.

98. Fu goes on, explaining further what it means to “plan[] its cleaning movements and adjust[] the working state of the four cleaning driving wheels 3 and the water discharger to complete the cleaning task.” Ex. 1007, [0026]. “For example, if the front wheels rotate quickly clockwise and the rear wheels rotate slowly counter-clockwise, the underwater cleaning robot will advance in the direction determined by the clockwise rotation of the front wheels, but the cleaning intensity in this case will be much greater than if the rear wheels were rotating clockwise. At the same time, adjusting the discharge position and direction of the water outlet 10 and the speed of the drainage propeller 11 can also change the cleaning intensity, making the robot's work more efficient.” Ex. 1007, [0026]. All Fu is describing is a process related to the cleaning intensity applied during the pre-planned coverage route, with the cleaning intensity based on the level (or lack thereof) of cleaning required based on a computed index of cleanliness.

99. A POSITA would have understood that Fu merely describes that its pool cleaner is able to control (i) the traverse-speed of the robot by adjusting the front and rear wheels to move faster or slower at the same speed and direction allowing the cleaner to spend less or more time over a particular spot that was more

or less-clean than specified by the threshold, (ii) change the relative speeds of the front and rear wheels to generate a certain brushing action to modulate mechanical debris-removal intensity, driven again by the level of cleanliness with respect to the cleanliness threshold, and (iii) controlling the speed of the drainage propeller sucking the water through the cleaner body and out the articulated water outlet, to increase the rate at which debris-laden water rushing over the particular surface-area to be cleaned can be used to improve on debris removal. A POSITA would thus have understood that Fu's cleaning-method implementation is solely directed at a combination of, at most, these three controllable variables based on the level of deviation from the cleanliness threshold identified by the on-board camera and its cleanliness level algorithm during the cleaning process of the robot, while it follows its pre-programmed cleaning coverage path. In sum, this means that Fu does not describe changing its cleaning coverage path or navigating to or away from a portion of the submerged surface in response to the captured image.

100. Fu's disclosure that the robot uses dead reckoning also confirms that Fu is not relying on the camera image to generate a control signal that moves the robot to or away from the imaged portion. Ex. 1007, [0026]. First, Fu states that, the robot "uses the inertial navigation components and the cleaning driving wheels 3 to perform dead reckoning to obtain its position information." Ex. 1007, [0026]. Fu also states that "[t]he underwater cleaning robot ensures autonomous navigation and

operation through dead reckoning, using its installed inertial navigation components and the encoders of the four cleaning driving wheels 3.” Ex. 1007, [0026]. Those disclosures describe navigation based on inertial components and wheel encoders, both components that are internal to the robot, not image-based steering to or away from a particular imaged portion of the submerged surface. Such a capability would require at a minimum an understanding of image-based scaling and sizing to even begin to generate accurate motion commands, as those in the Challenged Patents. Fu’s disclosure as to dead-reckoning is only applied to the direction and distance the robot is commanded to travel in order to stay on the prescribed path that has been pre-computed with path-following executed by the cleaner, without any regard to imaging data being used for changing travel direction of the pool cleaner at any point in the process, as is claimed in the Challenged Patents.

101. Dead reckoning means that the robot’s current position is estimated by taking a previously determined position and using the encoders on the wheels to estimate the distance traveled. This can be accomplished by taking the angular rotation of each wheel and multiplying it by the respective rotational ratio and associated circumference of the wheel, thereby allowing for the determination of relative and combined changes in heading and translation. However, regardless of how Fu’s system estimates its current position along its prescribed cleaning path, it is clear that it uses dead reckoning, which fully depends on internal evidence, so the

navigational movements are not determined by any external data, such as images captured by a camera.

102. The Petitions and Dr. Reinholtz rely on Fu's statement that, in autonomous mode, control signals are generated by the central processor based on information from the environmental perception layer and the robot's own position and attitude information. Ex. 1010, ¶ 150; *see also* '191 Patent Petition at 23. And Dr. Reinholtz opines that Fu's "central processor receives the captured image from the cameras 2 and generates control signals based on the captured image to instruct the motor drivers on how to move the robot." Ex. 1010, ¶ 150; *see also* Ex. 1010, ¶¶ 249, 383. In my opinion, that analysis does not identify where Fu actually describes the specific claimed relationship between the captured image of the first portion and movement of the body to or away from that first portion.

103. The Petitions and Dr. Reinholtz effectively infer the missing translational and directional limitation from the mere fact that Fu's robot can move. For example, the Petitions assert that any robot movement would necessarily be "to, or away from" the portion captured by Fu's cameras because any commanded movement will decrease or increase the distance between the robot body and the imaged portion. *See* '191 Patent Petition at 25. Dr. Reinholtz likewise states that "any robot movement would necessarily be 'to, or away from, the first portion' captured by Fu's monitoring cameras 2." Ex. 1010, ¶ 154; *see also* Ex. 1010, ¶¶ 252,

386. But that reasoning is not described anywhere in Fu; it is an after-the-fact, hindsight characterization that would convert any movement into the claimed “to, or away from” movement, and ignores the claim language, which states that the “a controller [is] configured to generate, *in response to the captured image*, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.” ’191 Patent, claims 1(g), 2(a)(iv)(iii), and 3(b)(ii) (emphasis added); ’766 Patent, claims 1(e)(iii), 2(e)(iii), 3(e)(iii), 4(e)(iii); ’207 Patent, claim 1(e). The reasoning applied in the Petitions and by Dr. Reinholtz does not account for the claim language I emphasized above, namely that the control signal that causes movement is “in response to the captured image.”

104. I also disagree with Dr. Reinholtz’s statement that “common sense dictates” that Fu’s robot “must necessarily be moving to the portion of the pool that failed to meet the cleanliness image threshold.” Ex. 1010, ¶ 155. Fu does not say that a portion failing the threshold is selected as a destination or target at any point during the cleaning process. Fu also does not say that a portion satisfying the threshold is treated as a region from which the robot should move away. At most, as I described above, Fu states that images are compared to a threshold to determine cleanliness of that region in the image and that the robot then plans varying levels of cleaning intensity and adjusts its wheel speeds/rotational-direction and water-discharge

operation to complete its cleaning task along a preset cleaning route. Fu's description of its pool cleaner's operation during the cleaning process does not teach the claimed controller configuration.

- 2) **A POSITA would not have found it obvious to modify Fu to disclose “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”**

105. In my opinion, the alternative obviousness theory in the Petitions and offered by Dr. Reinholtz fails at least because it does not explain why a POSITA would have modified Fu's control scheme in the particular manner required by the claims. As I have discussed above, Fu already describes how its robot navigates and operates: it plans cleaning intensity using information from the environmental perception layer and it navigates based on a preset cleaning task and coverage path, and controls its position and attitude along the prescribed trajectory through dead reckoning information using its inertial navigation components. Ex. 1007, [0023]–[0026]. The Petitions and Dr. Reinholtz do not identify any teaching in Fu that the robot (i) uses the camera image to localize the particular pictured portion of the pool surface, (ii) selects that portion as a target, nor (iii) that it generates a control signal that changes the robot's position and/or orientation relative to that portion.

106. A POSITA also would not have understood Fu's cleanliness-threshold disclosure, standing alone, to supply a reason to modify Fu to move toward some

regions and away from other regions. Fu states that the robot captures images of the pool floor, compares them with a cleanliness threshold to determine a level of cleanliness, and then plans cleaning action by adjusting wheel-speeds and water-discharge operation to complete the cleaning task by matching the above action to the encountered cleanliness level. Ex. 1007, [0026]. That disclosure is compatible with many control responses that Fu describes and that do not involve movement to or away from the imaged portion, including adjusting cleaning intensity, wheel speeds (including levels of front/rear wheel-set counter-rotation levels to generate a brushing action), water-discharge position, water-discharge direction, drainage-propeller speed, or the same general cleaning-intensity strategy used for vertical pool walls. Ex. 1007, [0026]. Because Fu expressly describes those cleaning strategies as non-directional (i.e., unrelated to creating changes in robot travel direction), a POSITA would not have viewed the Petitions and Dr. Reinholtz's proposed target-selection control scheme as the natural or necessary implementation of Fu.

107. The fact that Fu does not utilize the camera to make decisions related to navigating away from obstacles is further supported by the notion that the pre-determined cleaning coverage path is already laid out to presumably avoid any obstacles (stairs, gutters, protrusions, etc.), as Fu's system is not described as using its monitoring cameras for obstacle-detection nor -avoidance. Hence Fu is also not described as implementing any obstacle-detecting capability in the environmental

perception layer nor controller algorithms to combine therewith. Hence a POSITA's understanding of Fu's monitoring cameras being used exclusively for determining cleaning intensity would be bolstered even further.

108. Moreover, the Petitions and Dr. Reinholtz argue that “[a] POSA would have been motivated to implement Fu's pool-cleaning robot such that it moves towards dirtier (sub-threshold) regions and away from cleaner (above-threshold) regions because this would improve cleaning efficiency and task completion time. Ex. 1010, ¶ 166; *see also* Ex. 1010, ¶¶ 276, 439; '191 Patent Petition, at 30; '766 Patent Petition at 29; '207 Patent Petition at 32. I disagree.

109. Fu already declares that its “present invention” “exhibits good practicality, stability, energy efficiency, economy, and versatility.” Ex. 1007, Abstract. In my opinion, nothing in Fu expresses a need or motivation to replace multiple aspects of Fu's system as the Petitions and Dr. Reinholtz suggest. Neither the Petitions nor Dr. Reinholtz's declaration identifies why, or how, a POSITA would have been motivated to augment Fu, nor how such a technical leap would have been accomplished, let alone the associated need for the augmentation, nor the likelihood of success for such an augmentation or replacement.

110. The Petitions and Dr. Reinholtz's obviousness theory is also conclusory because it assumes that once Fu distinguishes a sub-cleanliness threshold and above-cleanliness threshold areas, a POSITA would simply use that information to guide

the robot toward dirty areas and away from clean areas. That assumption skips the identification and detailing of the technical steps needed to arrive at the claimed configuration, including at minimum (i) identifying the imaged portion as a spatially defined portion of the submerged surface, (ii) correlating (scaling, ranging, etc.) that portion in the image to the robot's position and heading, (iii) choosing whether to approach or avoid that portion (detection identification and classification related to debris and/or obstacle, etc.), and (iv) generating wheel-control signals that move (steering and driving) the body relative to that portion in the image, rather than merely adjusting cleaning intensity while continuing along a preset cleaning path. Neither the Petitions nor Dr. Reinholtz identifies a teaching in Fu that supplies those missing steps.

111. I also disagree that the proposed modification would have been merely a routine software re-configuration as Dr. Reinholtz suggests. Ex. 1010, ¶ 166; *see also* Ex. 1010, ¶¶ 276, 439; '191 Patent Petition, at 30; '766 Patent Petition at 29; '207 Patent Petition at 32. Petitioner and Dr. Reinholtz rely on the proposition that directing the robot toward dirtier regions and away from cleaner regions would improve cleaning efficiency and task completion time. Ex. 1010, ¶ 166; *see also* Ex. 1010, ¶¶ 276, 439; '191 Patent Petition, at 30; '766 Patent Petition at 29; '207 Patent Petition at 32. But Fu already addresses cleaning efficiency through its own mechanisms, including changing wheel-speed and wheel-spin direction

combinations to vary cleaning intensity, changing the water outlet's position and direction, changing drainage-propeller speed, and using dead reckoning with inertial navigation components and wheel encoders for autonomous navigation along its preset cleaning path. Ex. 1007, [0026]. A POSITA would have understood that Fu's approach to achieving improved cleanliness is to apply its cleaning-intensity method using wheel-speeds, front/rear wheel counter-rotations, water-suction propeller speeds and water outlet discharge orientation in combinations driven by a camera-based image analysis that determines a cleanliness level compared to a prescribed threshold and controls the above-outlined elements in a prescribed combination along an existing pre-computed trajectory that is part of the precomputed coverage algorithm path. A POSITA would have understood Fu's implementation as the use of the camera imaging system to drive the cleaning intensity elements on Fu's robot pool cleaner.

112. Indeed, Fu already declares that its "present invention" "exhibits good practicality, stability, energy efficiency, economy, and versatility." Ex. 1007, Abstract. Neither the Petitions nor Dr. Reinholtz explains, why a POSITA, starting from those elements, and a reference that already expresses its superior efficiency, would have been motivated to replace or supplement Fu's preset path and dead-reckoning approach with image-based controlled movements to or away from the particular pictured portion of the pool floor. All Dr. Reinholtz points to is an

expected increase in cleaning efficiency, even though Fu already deems his invention to have superior performance. The Petitions and Dr. Reinholtz's declaration presume a POSITA to seek additional efficiency by utilizing the cameras in Fu with additional image processing capability, completely disregarding the fact that nowhere in Fu or other cited prior art, was coverage efficiency identified or deemed in need of addressing, nor what additional capabilities (map-calibration, -registration and -localization and subsequent route re-planning) would be needed to arrive at the claimed invention(s) of the Challenged Patents.

113. Nor do the Petitions or Dr. Reinholtz establish a reasonable expectation of success for the proposed modification. Fu's camera disclosure is limited to capturing pool-floor images, calculating some sort of cleanliness metric for each of said images, and comparing them with a cleanliness threshold metric to determine a cleanliness level. Fu does not describe that its camera system determines the coordinates, boundaries, size, distance, or bearing of the imaged pool-floor portion relative to the robot. A POSITA would have understood that without that specific information, Fu's image comparison does not provide the essential controller algorithm inputs needed to generate a movement command that specifically moves the robot body to, or away from, the first portion of the submerged surface captured in the image.

114. Additionally, the Petitions and Dr. Reinholtz acknowledge that in prosecution, “The Notice of Allowance identified ‘a controller positioned on or in the body, in electronic communication with the at least one camera, and configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface’ as allegedly being inventive over the prior art.” ’191 Patent Petition at 6; Ex. 1010, ¶ 67. But despite failing to identify any prior art reference that describes this limitation, the Petitions and Dr. Reinholtz go on to conclude that the “inventive feature asserted by the Examiner was very well known in the art.” ’191 Patent Petition at 6; Ex. 1010, ¶ 67. And while they both recognize that Fu does not describe this claim limitation, they claim that it would have been obvious to arrive at said inventive feature, without providing any support describing the technical requirements or steps to be taken and how their implementation would have had a reasonable chance of succeeding.

115. In my opinion, the Petitions and Dr. Reinholtz’s alternative obviousness theory, based on Fu with the knowledge of a POSITA, rests on hindsight and conclusory suppositions, rather than on a teaching, suggestion, or articulated logical reasoning grounded in Fu.

116. For these reasons, a POSITA would not have found it obvious to modify Fu’s system of a controller that merely drives Fu’s system along a preset planned

path and modifies cleaning intensity actions along the prescribed path, to render obvious “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”

- 3) A POSITA would not have found it obvious to modify Fu in view of Benzler to disclose “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”**

117. The Petitions and Dr. Reinholtz alternatively argue that, even if Fu alone does not anticipate or render obvious the claimed “to, or away from” limitation, Fu in view of Benzler renders the limitation obvious. In my opinion, the proposed combination does not render obvious the claimed “controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.” (’191 Patent, Claims 1-3; ’766 Patent, Claims 1-2 and 4-

5 and the similar limitation recited by claim 3;<sup>1</sup> and the similar limitation recited by claim 1 of the '207 Patent<sup>2</sup>).

*i. There is no motivation to modify or combine Fu with Benzler.*

118. A POSITA would not have found it obvious to modify Fu's system in light of the teachings of Benzler.

119. Benzler is directed to a materially different navigation architecture than in Fu. Benzler is directed to a system that calculates a preset trajectory based on an external above-pool camera. Ex. 1013, [0029], [0053]. Benzler relies on a swimmer that is attached to the robotic vehicle but is above the water surface so the camera can determine its position and heading. Ex. 1013, [0029], [0031], [0053]. Benzler explains that the logic unit determines the position of the robotic vehicle in the work area based on images of the swimmer, and calculates driving instructions for proceeding within the work area boundaries. Ex. 1013, [0031], [0052], [0055]. By contrast, Fu describes traveling along a pre-determined cleaning coverage-task, using inertial navigation components with dead reckoning that combine to form a

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<sup>1</sup> Claim 3 of the '766 Patent recites: "controller ... configured to generate, in response to at least one of the captured image or information from the portable electronic device, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface."

<sup>2</sup> Claim 1 of the "'207 Patents recites: "controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first object."

self-attitude and positioning layer for navigating according to the preset cleaning task, and separately uses an onboard camera and an image acquisition card for collecting data to allow the controller to make a decision related to adjusting cleaning intensity. Ex. 1007, [0023]–[0026].

120. These materially different architectures are highlighted by the fact that Benzler touts the advantages of an above-pool camera and teaches away from Fu’s onboard control system with an onboard camera. Specifically, Benzler states that “[t]he invention is based on the idea to provide at least one camera that is arranged outside the robotic vehicle for detecting the work area as well as the robotic vehicle. The camera is preferably arranged above the work area, so that a section of the work area can be detected that is as big as possible with the camera, preferably a digital video camera.” Ex. 1013, [0010]. Benzler further states that “[a] further advantage of the activation system according to the invention is that the robotic vehicle can be construed simply because the logic unit, which preferably creates a digital map of the work area, is arranged outside of the robotic vehicle.” Ex. 1013, [0010]. Benzler explains that this all means that “the robotic vehicle can be produced less interference-prone and cheaper. Therefore the entire activation system according to the invention is less interference-prone, since it is possible to arrange the logic unit in an area that is mostly protected from external environmental influences, for example within a house or under a roofing.” Ex. 1013, [0010]. A POSITA would

have thus understood that Benzler teaches away from implementing an underwater camera on the pool robot. This sort of implementation is, however, exactly what the Petitions and Dr. Reinholtz propose. In my opinion this proposition in the Petitions and by Dr. Reinholtz is without merit.

121. The Petitions and Dr. Reinholtz do not explain why a POSITA would have reconfigured Fu's onboard, dead-reckoning-based underwater robot to use Benzler's external work-area camera and logic-unit architecture for the claimed movement relative to an imaged portion of the submerged surface. Instead, Dr. Reinholtz states in a conclusory manner that "[a] POSA would have been motivated to incorporate Benzler's classification-driven motion control into Fu because it is a known technique for improving coverage efficiency and cleaning performance, satisfies design needs to prioritize dirty areas and reduce redundant cleaning, and represents one of a finite, predictable set of control options once regions are classified with respect to a threshold." Ex. 1010, ¶ 174. But Dr. Reinholtz fails to provide any support for any of these opinions.

122. A POSITA seeking to improve on the accuracy and real-time trajectory-tracking of the pool-cleaner, would not have thought of a combination of Fu with Benzler. But even if they had, any combination of Fu with Benzler would still have merely resulted in a tracking of the pool robot along the prescribed coverage paths.

The addition of Benzler's pool-external camera would have been of no benefit to Fu's ability to control its cleaning-intensity nor-coverage.

123. Moreover, a POSITA would not have expected the combination of Fu and Benzler to succeed. Neither the Petitions nor Dr. Reinholtz address the fact that Benzler concedes that it (i) cannot image the underwater surface of the pool, nor (ii) determine the exact position of the pool cleaner without the use of its above-surface pole-mounted swimmer mounted to the robot. This is a problem with the Petitions and Dr. Reinholtz's conclusion that a "POSA would also have had a reasonable expectation of success." Ex. 1010, ¶ 175. Dr. Reinholtz asserts that "[t]he combination does not require new hardware or unconventional algorithms," but this is simply not true. Ex. 1010, ¶ 175. There are many environmental and technical factors that would make such a detection process not only extremely hard but also very unreliable to impossible, not even speaking about inaccurate, when simply relying on the hardware and software utilized in Fu and Benzler. Shadowing, glare, spectral absorption induced color loss, surface light-reflection and -refraction, water-surface rippling from wind/pumping action, and floating debris or other floating items (toys, etc.), are just some of the imaging-related factors that must be accounted for but are not addressed by Fu or Benzler. Indeed, Benzler concedes that its system cannot overcome even the singular impact of "reflecting water surface" to locate the robot cleaner. Thus, Benzler resorts to utilizing a non-submerged swimmer having

a contrasting color from the water surface, affixed to the submerged pool robot by a pole, in order to track the location and orientation of the submerged pool robot. Ex. 1013, [0029]. Accordingly, applying Benzler's camera to Fu would require an entirely different camera configuration that can be mounted in a sealed, underwater, compartment, as well as a significant redesign of the camera and related firmware and software to even begin to attempt to enable the globally-registered trajectory-planning and -following capability described by Benzler. Benzler's software would have had to have been augmented with higher-level software algorithms capable of: (i) global obstacle-detection and -avoidance (Ex. 1013, [0013]), and (ii) distinguishing between differently conditioned sections (mowed vs. not mowed as an analogy to cleaned vs. uncleaned areas) over the entire work surface (lawn as an analogy to submerged pool-floor) (Ex. 1013, [0016]). All of these are capabilities which Benzler only describes as a feature applicable to the lawnmower embodiment, as these are only possible within a system that has a complete and unimpeded ideal camera-viewing overview of the entire work area and its perimeter(s). Such a drastic redesign for use on an underwater pool cleaner would have been far from trivial or obvious and would be unlikely to have been successful at the relevant timeframe.

124. Therefore, a POSITA would not have been motivated to combine Fu with Benzler, nor reasonably expected this proposed combination to succeed.

***ii. Fu in combination with Benzler does not render obvious "a controller ... configured to generate, in***

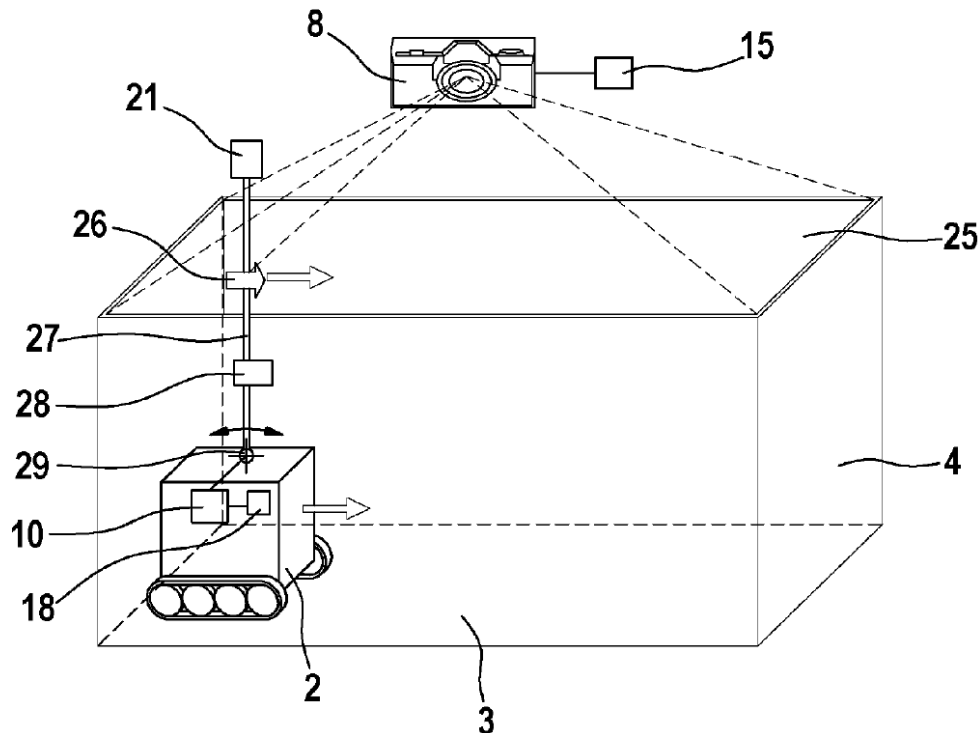
***response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”***

125. Notwithstanding that a POSITA would not have been motivated to combine Fu with Benzler, Fu in combination with Benzler does not render obvious “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface,” and the similar claim elements recited by claim 3 of the '766 Patent and Claim 1 of the '207 Patent. .

126. The Petitions and Dr. Reinholtz assert that Benzler describes “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface” because “Benzler, like Fu, describes an autonomous robotic cleaning system that makes movement and cleaning decisions based on an image of the cleaning surface or work area, including ‘differently conditioned’ sections of the work area.” Ex. 1010, ¶ 170; *see also* Ex. 1010, ¶¶ 279, 442; '191 Patent Petition at 33–34, '766 Patent Petition at 32, '207 Patent Petition at 34–35. I disagree.

127. Benzler’s pool-robot embodiment does not describe the claimed use of a captured image of a first portion of the submerged surface to generate a control signal that moves the body to or away from that portion. In the pool embodiment,

Benzler describes a robotic vehicle located on a work area created by a pool bottom and an external border created by pool walls. Ex. 1013, [0028]. The only optical detection device or system described in Benzler however, is a camera arranged above the water surface to detect a swimmer above the pool water surface to indicate position and orientation, carried along with the submerged robotic vehicle by a guiding rod mounted to the robotic vehicle. Ex. 1013, [0029]. I have included Figure 3 of Benzler below, illustrating the camera arranged above the water surface to detect the swimmer 26 above the pool water surface.



128. Benzler explains that “[i]n order for the digital camera, which is constructed above the pool, the swimming bath etc. and which is in particular construed as color camera, to be able to distinguish the robotic vehicle from ... the

blue and reflecting water surface, it is provided as an improvement of the invention that the robotic vehicle is equipped with a swimmer, which swims on the water surface.” Ex. 1013, [0029]. Benzler further explains that “when the color of the swimming (preferably red) differs from the color of the water surface (usually blue) the logic unit can determine the exact position of the swimmer and therefore of the robotic vehicle with the aid of the image data that is delivered by the camera.” Ex. 1013, [0031]. Thus, in Benzler’s pool embodiment, the camera is used to identify the contrast between the color of the non-submerged surface-floating swimmer and the water surface. Benzler’s pool embodiment cannot identify a dirty or clean portion of the submerged pool surface, which would be required for it to generate a control signal causing movement to or away from that particular portion.

129. Benzler’s trajectory-generation, -tracking, and -control description further confirms that its pool embodiment is not directed to image-based movement to or away from a first imaged portion of the submerged surface. Benzler describes trajectories based on external borders, and shifting the robot’s path with adjoining parallel tracks based on the (digitally-assigned) width of the non-submerged swimmer above the surface of the water to correspond to the width of the submerged robot. Ex. 1013, [0055]. For the pool embodiment, Benzler states that the logic unit preferably calculates a trajectory analogous to Figure 2 in Benzler, with rounds or ring tracks adjusted to the rectangular contour of the pool border. Ex. 1013, [0055].

None of these disclosures teaches a controller that uses an image of a particular first portion of the *submerged surface* to command the robot body to move to or away from that portion.

130. The Petitions and Dr. Reinholtz primarily rely on Benzler's embodiment of "differently conditioned sections," but that embodiment does not apply to Benzler's pool robot embodiment as the Petitions and Dr. Reinholtz suggest. Ex. 1010, ¶¶ 172–173. Benzler only discusses this type of motion control for the lawnmower embodiment and not the pool embodiment. Benzler's above ground camera may be capable of detecting mowed and non-mowed sections, but that detection algorithm is a far cry from algorithms required to detect dirt and/or debris on a submerged pool surface. That is because a POSITA would have understood that in Benzler's system, it is not possible to apply the "differently conditioned sections" of mowed/un-mowed lawn in the lawnmowing embodiment to the pool robot, as Benzler clearly states that it does not take images of the submerged surface, but it solely and exclusively "distinguish[es] the robotic vehicle [the swimmer] from, the environment, in particular from the blue and reflecting water surface." Ex. 1013, [0029].

131. Indeed, Benzler states that "[f]or an optical detection of the robotic vehicle 2 or a swimmer 26 that is swimming on the water surface 25, which is carried along with the robotic vehicle 2 when driving along the work area 3 over a guiding

rod 27 that is flexibly connected with the robotic vehicle 2, a camera 8 is provided, which is construed as a color digital camera and which is arranged above the water surface 25.” Ex. 1013, [0053]. Thus, a POSITA would have understood that Benzler’s system requires a swimmer above the surface of the pool because it can neither capture an image of the submerged surface nor the robot’s location or orientation in its submerged state, let alone that an attempt at extracting said information from the pool-overlooking camera, would be in any way reliable or usable for any cleaning operations. If it could, then there would be no need for the swimmer attached to the robotic cleaner. Accordingly, the “differently conditioned sections” embodiment in Benzler that the Petitions and Dr. Reinholtz primarily rely on, does not cure Fu’s deficiency.

132. Therefore, Fu in view of Benzler does not render obvious “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”

**C. A POSITA would not have found it obvious to modify Fu in view of Benzler to disclose “one or more cameras configured to capture video or images of at least a portion of a location including the swimming pool or spa, wherein the controller is remote from the camera.” (’207 Patent, Claim 11)**

133. As discussed above, in my opinion a POSITA would not be motivated to modify Fu based on Benzler. Further, claim 11 of the ’207 Patent requires that the

controller is remote from the camera. While this may be disclosed by Benzler, this is the opposite of what Fu teaches. The Petition and Dr. Reinholtz argue that a POSITA would have been motivated to “implement[] Benzler’s external camera 8 with Fu’s onboard controller.” ’207 Patent Petition, 40; Ex. 1010, ¶ 454. However, neither the Petition nor Dr. Reinholtz provide explanation of how a POSITA would have successfully modified Fu with Benzler’s exterior imaging system that tracks the location of a non-submerged swimmer and cannot image the submerged surface of the pool. Indeed, removing the camera from Fu would be counter to the entire concept described in Fu, as discussed above. Fu states that, during autonomous cleaning, “a pool cleanliness image threshold is set,” and that the robot uses monitoring cameras to capture images of the pool floor, and that the robot compares those images with the threshold to determine a “level of cleanliness.” Ex. 1007, [0026]. Fu then states that the robot “plans its cleaning movements” and “adjusts the working state” of the four cleaning driving wheels and the water discharger to complete the cleaning task. Ex. 1007, [0026]. Benzler’s camera, however, as discussed above, is not configured to capture images of the bottom of the pool, and instead must track the location of the pool robot via a swimmer traveling along the surface of the pool. Even if Dr. Reinholtz were to argue that the combination of Fu with Benzler were to use both the cameras and controllers of Fu’s in-pool robot and Benzler pool-external camera and controller, and seeing as the Petitions and Dr.

Reinholtz never even provide any technical detail for such a combination, a POSITA would be dissuaded from such a combination, as such a combination would (i) at minimum require a completely new and more complex multi-processor controller architecture, (ii) bring with it challenges in data-transmission bandwidth and latency which would greatly impact operational effectiveness and efficiency, and (iii) yield a system that is operationally cumbersome (if not impractical), given that the submerged robot is required to operate with a pole-mounted swimmer and antenna. A POSITA would have realized that such a combination would not have been advantageous nor have a clear and certain path to technical implementation success. Therefore, the Petition and Dr. Reinholtz do not explain how or why a POSITA would have found it obvious to modify Benzler's external camera that cannot image the submerged surface with Fu's controller, nor how a combination of Fu's camera and/or controller on the submerged in-pool robot would work with Benzler's pool-external external camera nor controller.

**D. Fu in view of Hui and/or Benzler does not render obvious claim 5 of the '766 Patent.**

**1) There is no motivation to modify or combine Fu with Hui or further modify or combine Fu and Hui with Benzler.**

134. A POSITA would not have found it obvious to modify Fu's system in light of the teachings of Hui.

135. Hui is directed to a robotic pool cleaner that operates materially differently than Fu. Attempting to implement Hui's chemical dispensing unit in Fu's robotic cleaner would be unsuccessful because the two systems are incompatible. Moreover, numerous supposed advantages stated by Hui or Fu about their respective systems would be lost by combining Hui's chemical dispensing unit with Fu's robotic cleaner.

136. Fu describes a particular advantage of its robot, namely that it "can be used for the underwater cleaning of swimming pool floors and walls." Ex. 1007, Abstract. Fu's robotic pool cleaner accomplishes this multi-surface cleaning capability by adjusting the intensity, position, and direction of the water discharge. Ex. 1007, [0010], [0011], [0012], [0026]. Specifically, "[a] feature of the underwater cleaning robot proposed by the present invention is that the high negative pressure within the robot's water flow channel and the force from the drainage mechanism enable the robot to adhere to and clean the vertical walls of a swimming pool, achieving vertical wall-climbing movement." Ex. 1007, [0011]. And "when the robot is climbing a wall, factors such as pool steps may cause the chassis to be lifted, rendering the four cleaning driving wheels ineffective. In this situation, the position of the water outlets must be adjusted to provide a propulsive force to the robot, returning it to a normal operating state." Ex. 1007, [0012]. Furthermore, as another feature "when the robot is in a floating state in the water, adjusting the discharge

direction and force of the two water outlets can regulate the robot's attitude in the water, helping it maintain a correct posture." Ex. 1007, [0012]. These adjustments to account for floating, wall climbing and steps, are made by "[t]he coordinated movement or positioning of multiple water outlets along the water outlet sliding grooves chang[ing] direction discharge, generating different forces that affect the robot's movement." Ex. 1007, [0012]. There are also times when Fu's robotic pool cleaner does not circulate water and there is no water flow. Ex. 1007, [0010]. In sum, Fu's robotic pool cleaner is specifically designed to include the ability to climb walls and handle steps and float along the surface by adjusting the intensity, position, and direction of the water discharge.

137. Hui's proposed pool cleaner, however, is limited to a cleaner that "operates at the floor of the pool." Ex. 1019, [0041]. This is for a very specific reason: "mixing of the chemicals released by the chemical dispenser member 30 occurs at the bottom of the pool. By mixing the chemicals at the lower depths of the pool water, complete mixing is encouraged. Unlike releasing chemicals at the surface water level where the chemicals to be dissolved in the water are much more likely to evaporate or become ineffective before complete mixing." Ex. 1019, [0041].

138. If one were to modify or combine Fu's robotic pool cleaner with Hui's chemical dispenser, then the chemical dispenser would not work according to Hui's

usage-limitation, because Fu's robotic pool cleaner does not stay on the floor of the pool, as it also climbs walls and steps, and floats at the surface of the pool. If one were to modify Fu's robotic pool cleaner such that Hui's chemical dispenser was operational, thus limiting the cleaner to floor operation only, it would forfeit several of the advantages that Fu explains as integral to its pool cleaner.

139. Hui's chemical dispenser would also not work when implemented into Fu's robotic pool cleaner because the water flow rate through Fu's system is variable. Ex. 1007, [0010], [0011], [0012], [0026]. A variable flow rate would not work with Hui's chemical dispenser, which requires a predictable and precise flow rate. Hui states that in order to properly sanitize the pool with chemicals, "adding chemicals to pool water requires some precision." Ex. 1019, [0006]. Predictability and precision in adding chemicals to pool water is important because adding too little chemicals would leave the pool dirty and not sanitized, while "adding too much of a particular chemical, such as chlorine, could equally make the pool water dangerous and unsafe for human usage." Ex. 1019, [0006]. "Thus, a balance needs to be struck between no chemicals or too little chemicals and too much chemicals." Ex. 1019, [0007]. Accordingly, Hui requires that its chemical dispenser "add the proper chemicals in the right amounts." Ex. 1019, [0013]. Because Fu's robotic pool cleaner utilizes a variable water flow rate to perform its moving and cleaning operations, a predictable and precise flow of water through the chemical dispenser

and most importantly the rate and distribution of the chemical at a particular location within the pool, cannot be guaranteed nor properly controlled. In other words, a variable water flow as in Fu's robotic pool cleaner would make it impossible to ensure that the correct amount of chemicals is added to the water as required in Hui's chemical dispenser. Further, Fu's variable cleaning intensity incorporates variable water-flow at all times during its cleaning operation, thus the same issue arises even if Fu's cleaner were somehow modified to stay only on the bottom surface of the pool.

140. Not only would implementing Hui's chemical dispensing unit in Fu's robotic cleaner be unsuccessful, a POSITA would not have been motivated to try it in the first place. In addition to recognizing that it would not result in a proper chemical-dispensing implementation as described by Hui, Hui actually teaches away from Fu's movements. Specifically, Hui states that the robot should not be operated near the surface water level and chemicals must be dispensed at the bottom of the pool. Ex. 1019, [0041], [0052]. This is because chemicals dispensed at the surface water level are "much more likely to evaporate or become ineffective before complete mixing." Ex. 1019, [0041]. Thus, Hui specifically teaches a POSITA that its chemical dispenser should not be applied to a robotic pool cleaner like Fu's that includes a "floating state in the water." Ex. 1007, [0026].

141. Additionally, adding Hui's chemical dispenser to Fu's robotic pool cleaner would negate Fu's stated benefit of "being lightweight" and "agile and nimble in movement." Ex. 1007, Abstract, [0013]. Additionally, Fu states that its robotic pool cleaner "features a compact and rational mechanical structure and exhibits good ... stability." Ex. 1007, [0013]. These advantages allow Fu's cleaner to operate on floors, climb walls, float, and maneuver steps. Ex. 1007, [0013], [0011], [0012], [0026]. The addition of a chemical dispenser like Hui's to Fu's robotic pool cleaner would add significant weight and alter the location of the center of gravity of the robotic pool cleaner greatly impacting its ability to climb walls, float, or maneuver steps.

142. The Petitions and Dr. Reinholtz argue that "a POSA would have been motivated to incorporate Hui's chemical dispenser 30 into Fu's autonomous pool cleaning robot to achieve a predictable improvement—a pool cleaning robot that filters as well as sanitizes pool water." Ex. 1010, ¶ 289; Petition at 39. I disagree. As I stated above, a POSITA would not have been motivated to incorporate Hui's chemical dispenser into Fu's pool cleaning robot because Hui specifically teaches against the use of its chemical dispenser in the manner that Fu's robotic pool cleaner operates, namely climbing walls, floating on the surface of the water, traversing steps, and varying the water output through the robotic pool cleaner's water flow channel. As stated earlier, even if Dr. Reinholtz were to argue that such a

combination was limited to dispensing chemicals only when on the submerged pool floor surface, it would negate the ability to properly control the application-rate and dispersion-behavior of the chemical due to the continuously varying flow-rate of the water-flow used in Fu during its continuously varying cleaning-intensity process.

143. The Petitions and Dr. Reinholtz also argue that a “POSA would have had a reasonable expectation of success in combining these references.” Ex. 1010, ¶ 290. I disagree. As I stated above, incorporating Hui’s chemical dispenser into Fu’s pool cleaning robot would not have resulted in a successful combination. Hui’s chemical dispenser requires the robotic pool cleaner to be limited to chemical-dispensing movements on the floor of the pool because dispensing the chemicals near the surface of the pool would not result in a successful cleaning. Ex. 1019, [0041], [0052]. But Fu’s robotic pool cleaner also operates near the surface of the water when it climbs walls, floats at the surface, and traverses steps. Ex. 1007, [0013], [0011], [0012], [0026]. A POSITA would recognize that such a combination would result in an even less efficient pool cleaning system, as the combined system would have to perform the chemical application step during an additional traversal of the entire pool floor, while not performing any cleaning operation, to avoid the variable water-flow conditions – such a requirement would thus no longer result in an “energy efficien[t]” invention as stipulated by Fu. Ex. 1007, [0013]. Hui’s chemical dispenser also requires predictable and precise water flow to ensure the

“proper balance” of neither too much or too little chemicals in the pool. Ex. 1019, [0007]. But since Fu’s robotic pool cleaner features a variable water flow rate, the steps of floor-cleaning and chemical-application would have to be carried out separately and thus resulted in a system with reduced efficient operations. Ex. 1007, [0010], [0012], [0026].

144. Thus, Dr. Reinholtz is wrong in his assertion that “[a] POSA could easily integrate Hui’s chemical dispenser before being discharged into the pool.” Ex. 1010, ¶ 290. And he is also wrong in his assertion that “a POSA could also mount Hui’s chemical dispenser 30 externally to the underwater vehicle.” Ex. 1010, ¶ 290. This is because regardless of whether the chemical dispenser is mounted internally or externally to Fu’s robotic pool cleaner, the intended operation of both Fu’s robotic pool cleaner and Hui’s chemical dispenser would be thwarted—Fu’s robotic pool cleaner could not effectively navigate the pool walls, float at the surface of the pool, or use its variable-flow directional water outlet(s), and Hui’s chemical dispenser would not effectively disperse chemicals in a controlled, safe, effective, and efficient manner.

145. Therefore, a POSITA would not have been motivated to combine Fu with Hui, nor reasonably expected this proposed combination to succeed. Accordingly, Fu in view of Hui and/or Benzler does not render obvious claim 5 of the ’766 Patent.

**E. Schnittman in view of Benzler.**

**1) There is no motivation to modify or combine Schnittman with Benzler.**

146. A POSITA would not have found it obvious to combine Schnittman with Benzler.

147. The Petitions and Dr. Reinholtz contend that “[a] POSA would have been motivated to consider Schnittman and Benzler together because they describe similar technology (*e.g.*, autonomous cleaning robots that employ computer vision) and address the same problem: enabling a robot to make cleaning and navigation decision based on an image of the cleaning surface.” Ex. 1010, ¶ 184; *see also* Ex. 1010, ¶¶ 299, 461; ’191 Patent Petition at 45; ’766 Patent Petition at 47; ’207 Patent Petition at 47. I disagree.

148. First, and foremost, a POSITA would not have considered Schnittman in designing a robotic pool cleaner as claimed in the Challenged Patents. Schnittman is not in the same field of endeavor as the Challenged Patents, despite the Petitions and Dr. Reinholtz stating so. Schnittman is directed to land-based/terrestrial robots, which is different from underwater autonomous cleaning robots. Ex. 1008, [0003], [0161], [0248]. A POSITA would not have looked to terrestrial autonomous robots when faced with the problems outlined in the Challenged Patents. This is because a POSITA would know of the difficulties and undue experimentation required to convert aspects of Schnittman to an underwater cleaning robot. Indeed, the

differences in the environment alone—given that water is approximately 800 times denser than air—would require different types of hardware (including at least cameras, mechanics, seals, pumps, wheels, motors, housings, and filters) and software. These differences and the difficulties associated with addressing these were not “straightforward and within a POSA’s skill,” as the Petitions claim. ’191 Patent Petition at 48; *see also* ’766 Patent Petition at 50; ’207 Patent Petition at 49; Ex. 1010, ¶¶ 188, 303, 465.

149. For example, there are camera-calibration issues related to light-transmission through multiple media (refraction, reflection, transmission and dispersion) associated with the camera setup and lensing required for underwater navigation. There are multiple air-to-lens-to-air-to-glass-to-water transitions requiring intricate calibration algorithms that must be accounted for that are not an issue in terrestrial camera use. There are challenges due to light-reflection and -refraction as related to light-bouncing off suspended matter within the water column at unpredictable angles, which are not at play in indoor terrestrial camera use. There is a lack of contrast underwater that is more readily observable in terrestrial camera use. And there are lighting issues from shadowing, whether static or dynamic, and overall and frequency-specific light absorption is prevalent in real-world underwater settings but nowhere near as much in terrestrial indoor camera settings. As I described in the above section on the Background of the Technology, these are just

some of the problems that a POSITA would have encountered when attempting to use a camera underwater for the navigation of a robotic pool cleaner.

150. Other problems that a POSITA would have encountered include more challenging electro-mechanical setups to ensure waterproofing, complex software-augmentations related to data-interpretation and -fusion, and complex processing techniques that further complicate such an endeavor. Further still, difficulties with traction and mobility, buoyancy of the robot, suspension of debris, prevention of debris backflow, and fluid-dynamic resistance (center-of-thrust vs. center-of-drag vs. center-of-buoyancy, etc.) in an underwater setting are all challenges presented in underwater robots, but not terrestrial robots. Similarly, a terrestrial vacuum relies on an air-pump and air-filter, neither of which is configured to operate in an underwater environment. The same can be said for the battery of a terrestrial robot, which likely would short or be damaged when immersed in water. Indeed, essentially all electrical components in a terrestrial robot would require substantial redesign and/or waterproofing and/or sealing, which brings with it more challenges given that many of these components (motors, pumps, wheels, etc.) require separate housings, interconnecting wires/connectors with additional seals for proper operation.

151. Therefore, due to the vast differences between underwater and terrestrial camera use, a POSITA simply would not have looked to the terrestrial robotic application domain to address the problems addressed by the Challenged

Patents, and if they had, they would have been readily dissuaded from using any terrestrial robotics systems underwater due to the complexity and undue experimentation required to arrive at a reliable and successful implementation.

152. Even if a POSITA had looked to Schnittman as the Petitions and Dr. Reinholtz suggest, a POSITA would not have been motivated to combine Schnittman and Benzler. Schnittman and Benzler exhibit completely different system architectures in different fields of endeavor. Schnittman describes a self-contained terrestrial robotic floor cleaner with onboard components. Ex. 1008, [0003], [0161], [0248]. Benzler, by contrast, is directed to an activation system in which an external camera generates image data, a logic unit determines the position of the robotic vehicle and calculates driving instruction based on the work area. Ex. 1013, Abstract, [0012]. A POSITA would have understood that these are not simply interchangeable approaches, as they allocate perception, localization, trajectory planning, and vehicle control, differently. These different approaches would require different types of cameras, mechanics, and software for their respective purposes and environments. For example, the camera, mechanics, and software for Schnittman would need to account for movement of the camera on the cleaner that would result in shaking/vibration, visual perspective changes, field of view changes, and focus (re-)adjustments, which would all have to be compensated for when combining said cleaner-based imagery with Benzler's overview camera-imaging

data. The Petitions and Dr. Reinholtz fail to address any of these problems within their combination of Schnittman with Benzler.

153. A POSITA also would not have been motivated to combine Schnittman with Benzler's pool robot embodiment because Benzler teaches away from implementing a camera on the pool robot submerged underwater as Benzler touts the advantages of an above-pool camera. Specifically, Benzler states that "[t]he invention is based on the idea to provide at least one camera that is arranged outside the robotic vehicle for detecting the work area as well as the robotic vehicle. The camera is preferably arranged above the work area, so that a section of the work area can be detected that is as big as possible with the camera, preferably a digital video camera." Ex. 1013, [0010]. Benzler further states that "[a] further advantage of the activation system according to the invention is that the robotic vehicle can be construed simply because the logic unit, which preferably creates a digital map of the work area, is arranged outside of the robotic vehicle." Ex. 1013, [0010]. Benzler explains that this all means that "the robotic vehicle can be produced less interference-prone and cheaper. Therefore the entire activation system according to the invention is less interference-prone, since it is possible to arrange the logic unit in an area that is mostly protected from external environmental influences, for example within a house or under a roofing." Ex. 1013, [0010]. Accordingly, a POSITA would have thus understood that Benzler teaches away from implementing

a camera underwater on the pool robot. This sort of implementation, however, is exactly what the Petitions and Dr. Reinholtz propose. And thus, in my opinion, this proposition by the Petitions and Dr. Reinholtz is without merit.

154. The Petitions and Dr. Reinholtz assert that Benzler “describes the same image-driven framework as Schnittman, with Benzler applying this framework to both land and water environments.” ’191 Patent Petition at 46; *see also* ’766 Patent Petition at 49; ’207 Patent Petition at 48; Ex. 1010, ¶¶ 185, 300, 462. They also state that “[b]y describing the same image-based system across multiple domains, land and water alike, Benzler demonstrates that a POSA understood how to adapt the principles of image-based robotic navigation and cleaning across various environments and mediums.” ’191 Patent Petition at 47–48; *see also* ’766 Patent Petition at 49; ’207 Patent Petition at 48–49; Ex. 1010, ¶¶ 187, 302, 464. Neither of these assertions are true: (i) Benzler and Schnittman do not “describe[] the same image-driven framework”; and (ii) Benzler does not describe “the same image-based system across multiple domains, land and water alike.”

155. Benzler’s pool-robot embodiment does not describe the use of a captured image of a first portion of the submerged surface to generate a control signal that moves the body to or away from that portion. In the pool embodiment, Benzler describes a robotic vehicle located on a work area created by a pool bottom and an external border created by pool walls. Ex. 1013, [0028]. The only pool-based

optical detection device or system described in Benzler is a camera arranged above the water surface to detect a swimmer above the pool water surface to indicate position and orientation, carried along with the submerged robotic vehicle by a guiding rod mounted to the robotic vehicle. Ex. 1013, [0029]. Specifically, Benzler explains that “[i]n order for the digital camera, which is constructed above the pool, the swimming bath etc. and which is in particular construed as color camera, to be able to distinguish the robotic vehicle from ... the blue and reflecting water surface, it is provided as an improvement of the invention that the robotic vehicle is equipped with a swimmer, which swims on the water surface.” Ex. 1013, [0029]. Benzler further explains that “when the color of the swimming (preferably red) differs from the color of the water surface (usually blue) the logic unit can determine the exact position of the swimmer and therefore of the robotic vehicle with the aid of the image data that is delivered by the camera.” Ex. 1013, [0031]. Thus, in Benzler’s pool embodiment, the camera is used to track the vehicle via its swimmer for trajectory following purposes, and not to identify a dirty or clean portion of the submerged pool surface and generate a control signal causing movement to or away from that particular portion.

156. Benzler’s trajectory-generation, -tracking, and -control disclosure further confirms that its pool embodiment is not directed to image-based movement to or away from a first imaged portion of the submerged surface. Benzler describes

trajectories based on external borders, and shifting the robot's path with adjoining parallel tracks based on the (digitally-assigned) width of the swimmer above the surface of the water to correspond to the width of the submerged robot. Ex. 1013, [0055]. And it is worth noting that Benzler clearly states that its pool-external camera-imaging system is not able to detect the underwater pool surfaces, which a POSITA would have concluded would render its feature-tracking (mowed/unmowed boundaries, obstacles) in its lawnmower implementation, completely impractical and non-applicable to an underwater application. For the pool embodiment, Benzler states that the logic unit preferably calculates a trajectory analogous to its Figure 2, with rounds or ring tracks adjusted to the rectangular contour of the pool border. Ex. 1013, [0055]. Thus, Benzler's camera usage in its pool robot embodiment is different from its land-based embodiment and differs drastically from Schnittman's framework.

157. Moreover, a POSITA would not have expected the combination of Schnittman and Benzler to succeed. Schnittman describes a self-contained terrestrial robotic cleaner with onboard components. Ex. 1008, [0003], [0161], [0248]. Benzler, by contrast, is directed to an activation system in which an external camera situated above the pool generates image data, a logic unit determines the position of a non-submerged swimmer above the surface of the pool and calculates driving instructions, and those instructions are transmitted to a receiving unit at the robotic

vehicle. Ex. 1013, Abstract. Neither Schnittman nor Benzler describes an underwater camera. And a POSITA would not have found it obvious, in view of Schnittman and Benzler, to employ a camera underwater, particularly when neither reference provides any direction as to how that could be accomplished, and Benzler even concedes that its system cannot overcome the singular impact of “reflecting water surface” to even locate the robot cleaner when submerged. Ex. 1013, [0029].

158. Moreover, a POSITA would have understood that Benzler teaches away from implementing a camera underwater on the pool robot. This sort of implementation is, however, exactly what the Petitions and Dr. Reinholtz propose. For example, Benzler states that “[t]he invention is based on the idea to provide at least one camera that is arranged outside the robotic vehicle for detecting the work area as well as the robotic vehicle. The camera is preferably arranged above the work area, so that a section of the work area can be detected that is as big as possible with the camera, preferably a digital video camera.” Ex. 1013, [0010]. Benzler further states that “[a] further advantage of the activation system according to the invention is that the robotic vehicle can be construed simply because the logic unit, which preferably creates a digital map of the work area, is arranged outside of the robotic vehicle.” Ex. 1013, [0010]. Benzler explains that this all means that “the robotic vehicle can be produced less interference-prone and cheaper. Therefore the entire activation system according to the invention is less interference-prone, since it is

possible to arrange the logic unit in an area that is mostly protected from external environmental influences, for example within a house or under a roofing.” Ex. 1013, [0010].

159. Therefore, a POSITA would not have been motivated to combine Schnittman with Benzler, nor reasonably expected this proposed combination to succeed.

**2) Schnittman in view of Benzler does not render obvious “a filter configured to retain debris collected from the submerged surface.”**

160. Claims 1–3 of the ’191 Patent, claims 1–5 of the ’766 Patent, and claim 1 of the ’207 Patent require “a filter configured to retain debris collected from the submerged surface.”

161. The Petitions and Dr. Reinholtz assert that “Schnittman’s internal filter 54 is configured to retain debris collected from a cleaning surface, such as a ‘submerged surface.’” Ex. 1010, ¶ 206; *see also* Ex. 1010, ¶ 317, 480; ’191 Patent Petition at 55; ’766 Patent Petition at 55; ’207 Patent Petition at 55. I disagree.

162. Although Schnittman does describe an internal filter element, it does not indicate that the filter is configured to retain debris. Instead, Schnittman states that “debris is separated from the air,” when it moves through a filter, “with the debris remaining in the bin 50’ (e.g., in a portion of the bin 50’ at least partially defined by barrier 55).” Ex. 1008 [0247], Figure 1C, 19F. And Schnittman even

states that “barrier 55 defines at least a portion of a compartment that retains debris settled at the bottom of the bin 50' when the bin is in situ in the robot 11'.” Ex. 1008, [0243]. Furthermore, “[i]n certain implementations, at least a portion of the barrier 55 is a door (e.g., a hinged door and/or a slidable door) that is movable to allow access to debris stored in the bin 50'. In some implementations, the barrier 55 is rigidly fixed relative to the mouth 53' and access to debris is obtained through one or more doors forming part of a side wall, a bottom wall, or a rear wall of the bin 50'.” Ex. 1008, [0243]. I have reproduced Figures 1C and 19F below and annotated each to illustrate that the filter is not configured to retain debris. As I have shown in my annotations to Figure 1C, the filter 54, highlighted in blue, is not configured to retain debris because it sits atop the bin 50, which retains the debris, highlighted in red, that may be evacuated through evacuation port 80. Ex. 1008, [0117].

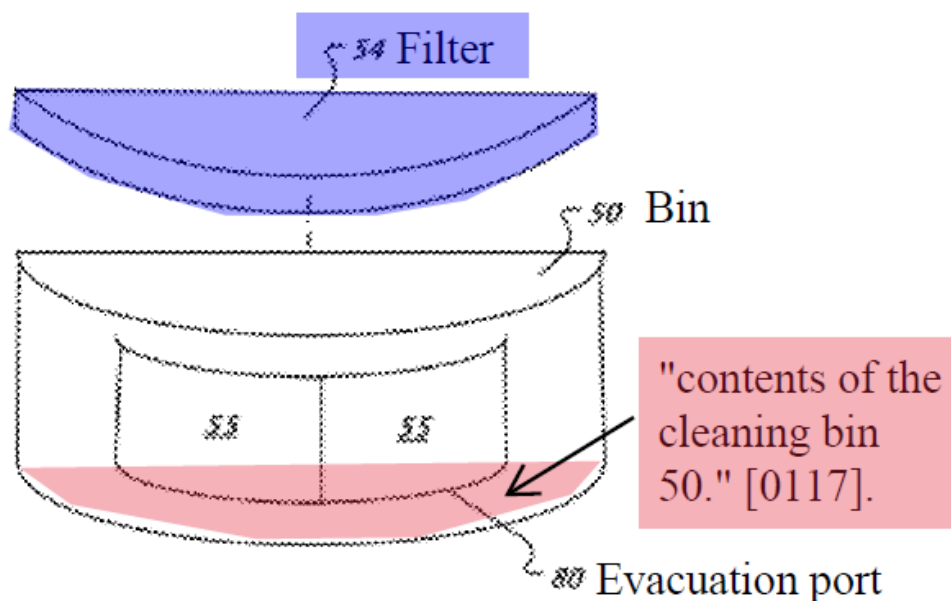


FIG. 1C

163. As I have shown in my annotations to Figure 19C, the filter 811, highlighted in blue, is not configured to retain debris; rather, the bin 50 delimited by barrier 55, highlighted in green, is the “portion of a compartment that retains debris,” which I have highlighted in red. Ex. 1008, [0243].

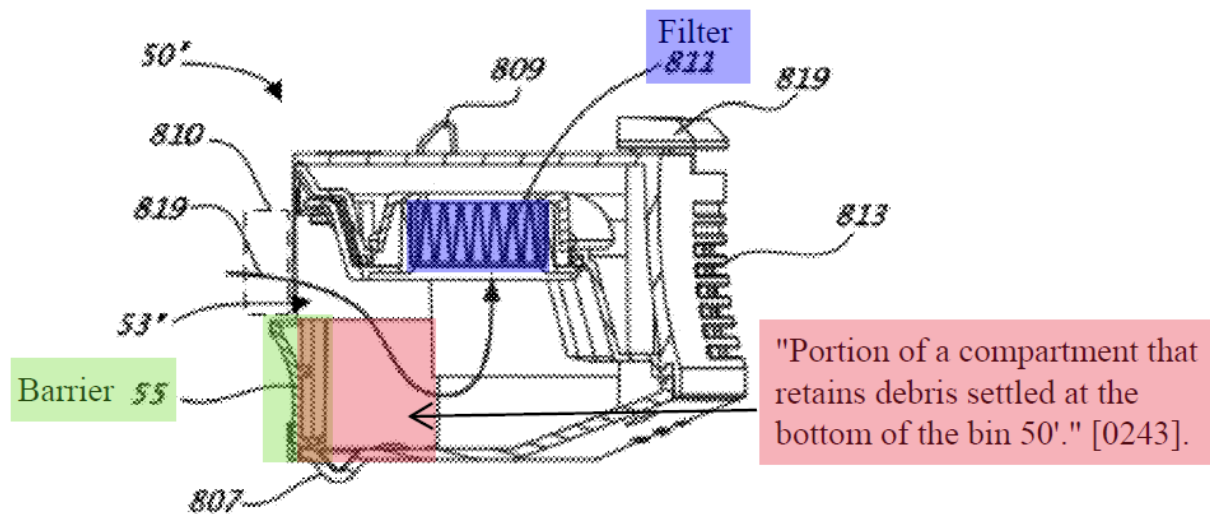


FIG. 19F

164. As I have shown above, a POSITA would readily recognize that the filter 54 in Figure 1C and filter 811 in Figure 19F are not configured to retain debris as required by claims 1–3 because they are situated in completely separate portions of the bin wherein debris is retained, and rely on the other element, namely bin 50, to provide a debris-retention feature.

165. The Petitions and Dr. Reinholtz suggest that simply because the internal filter in Schnittman may be cleaned, that must mean that it retains debris, citing to paragraphs 123 to 124. Ex. 1010, ¶ 206; *see also* Ex. 1010, ¶¶ 317, 480; '191 Patent

Petition at 55; '766 Patent Petition at 55; '207 Patent Petition at 55. But Schnittman does not state that the filter must be cleaned to remove the debris. And Schnittman actually states in the very next paragraph that debris is retained in the bin, not the filter: “[t]he evacuation ports 380 may be configured to receive an evacuation hose for removing debris from the bin 310F. Additionally or alternatively, the evacuation ports 380 may be configured to facilitate manual removal of debris (e.g., by holding the bin 310F to allow debris within the bin to fall out of the bin under the force of gravity).” Ex. 1008, [0125]; *see also* Ex. 1008, [0126]–[0127], [0247]. Thus, in Schnittman’s system, the debris accumulates at the bottom of the bin, which is configured to retain the debris, not the filter. *See e.g.*, Ex. 1008, [0117], [0125]–[0127], [0145]–[0146], [0243], [0247].

166. The Petitions and Dr. Reinholtz also summarily conclude that “a POSA would have understood how to modify or replace Schnittman’s filter for use in Benzler’s pool-cleaning context,” and points back to their general “Motivations to Combine” sections. Ex. 1010, ¶ 206; *see also* Ex. 1010, ¶¶ 317, 480; '191 Patent Petition at 55; '766 Patent Petition at 55; '207 Patent Petition at 55. I disagree.

167. First, neither the Petitions nor Dr. Reinholtz’s “Motivations to Combine” sections specifically address the motivations, the technical steps required, nor the expectation of success for such a combination, were a POSITA to have gone down the path of utilizing Schnittman’s filter in an underwater pool environment.

See Ex. 1010, ¶¶ 179–192, 295–304, 457–466; ’191 Patent Petition at 43–49; ’766 Patent Petition at 47–50; ’207 Patent Petition at 47–50.

168. Second, Dr. Reinholtz states that “the same mechanical elements are commonly used to filter both water and air. These elements include a motor-driven impeller to move the fluid and a filter to retain the debris. In common wet/dry vacuum cleaners, these elements can handle either water or air as the fluid.” Ex. 1010, ¶ 206. However, Dr. Reinholtz provides no support for this statement. And I disagree with his proposition.

169. The example of a wet/dry vac is not equivalent to a robotic pool cleaner’s filtering operation. Indeed, the wet/dry vac is not completely submerged underwater, and thus the components are necessarily different and must account for this complete submersion. Additionally, the absence of being submerged in water means that the filter for wet/dry vac operations does not need to account for the additional buoyancy/suspension of the debris collected underwater and prevention of debris backflow, whereas the robotic pool cleaner would need to address these problems. Furthermore, any POSITA would have understood that a terrestrial wet/dry vac relies on centrifugally-directed airflow to deposit water/dust along the inside of the shell/body of the vacuum before the air is allowed to escape through a (typically central) filter element, again indicating a different type of filtering process and design, highlighting the difference in filtering vs. retaining. Also, a POSITA

would further have known that such a wet/dry vac requires different filtering elements to operate properly in a terrestrial environment handling air-entrained debris versus debris suspended in aspirated water, as is clearly detailed in any operating manual of a wet/dry vac, underscoring the need for careful attention needing to be paid to the application of such vacuums, without even considering the technical challenges of how to implement the proper filtering-and-retaining element on an underwater pool cleaner. Lastly, the filter in the wet/dry vac does not need to account for the mobility of the robotic pool cleaner nor the retention and release of debris by an operator during cleanout steps, which creates additional factors and complications for retaining debris in the filter.

170. Third, for similar reasons that a filter for a wet/dry vac is not an appropriate guide for designing a robotic pool cleaner with a “filter configured to retain debris collected from the submerged surface,” Schnittman does not render this claim limitation obvious. A POSITA would not have been motivated to modify or replace Schnittman’s filter, which merely filters air, and bin, which collects the debris, for use in Benzler’s pool-cleaning context.

171. Finally, Benzler also does not describe a filter configured to retain debris. Benzler only mentions a filter twice in the context of a “filter vehicle,” and never describes the actual location of a filter, the operation of a filter, or that a filter is configured to retain debris. Ex. 1013, [0002], Claim 22.

172. Therefore, Schnittman in view of Benzler does not render obvious “a filter configured to retain debris collected from the submerged surface.”

**3) Schnittman in view of Benzler does not render obvious “at least one camera positioned on or in the body for capturing an image of at least a first portion of the submerged surface.”**

173. Claims 1–3 of the ’191 Patent require “at least one camera positioned on or in the body for capturing an image of at least a first portion of the submerged surface.” Claim 1 of the ’766 Patent is substantially the same, requiring “at least one camera mounted directly or indirectly to the body for capturing an image of at least a first portion of the submerged surface.” Claim 2 of the ’766 Patent is also substantially the same, requiring “at least one camera carried by the body for capturing an image of at least a first portion of the submerged surface.” Likewise, claim 3 of the ’766 Patent is substantially the same, requiring “at least one camera positioned on or in, or carried by, the body for capturing an image of at least a first portion of the submerged surface.” Similarly, claim 5 of the ’766 Patent is substantially the same, requiring “at least one camera on, in, or carried by the vehicle body, for capturing an image of at least a first portion of the submerged surface.”

174. The Petitions and Dr. Reinholtz concede that “Schnittman does not disclose capturing an image of a ‘submerged [underwater] surface.’” Ex. 1010, ¶ 210; *see also* Ex. 1010, ¶¶ 320, 484; ’191 Patent Petition at 57; ’766 Patent Petition at 58; ’207 Patent Petition at 57. I agree that Schnittman does not disclose “at least

one camera positioned on or in the body for capturing an image of at least a first portion of the submerged surface.”

175. The Petitions and Dr. Reinholtz, however, assert that despite Schnittman not disclosing “capturing an image of a ‘submerged [underwater] surface,’ specifically, a pool-cleaner implementation of Schnittman in view of Benzler would capture such an image.” Ex. 1010, ¶ 210; *see also* Ex. 1010, ¶¶ 320, 484; ’191 Patent Petition at 57; ’766 Patent Petition at 58; ’207 Patent Petition at 57. I disagree.

176. Neither the Petitions nor Dr. Reinholtz explain what aspects of Schnittman and/or Benzler would be modified or combined in order to create the “at least one camera positioned on or in the body for capturing an image of at least a first portion of the submerged surface.” Instead, the Petitions and Dr. Reinholtz simply point back to their discussion about why, in their view, a POSITA would have been motivated to combine Schnittman with Benzler. Their discussion simply lacks (i) an identification of the technical elements, (ii) the required improvements to the same, (iii) the combination and interconnection of key existing or even novel technical elements, and (iv) what level of experimentation and integration would be required and (v) how such steps would yield a reasonable chance for a successful outcome. The Petitions and Dr. Reinholtz simply state that a combination of the described elements by a POSITA would succeed without providing any technical

detail, and is therefore overly simplistic and conclusory. As I have discussed above, a POSITA would not have been motivated to combine Schnittman with Benzler, nor would a POSITA have had any reasonable expectation of success in combining the two references.

177. To be sure, Schnittman describes a self-contained terrestrial robotic cleaner with onboard components. Ex. 1008, [0003], [0161], [0248]. Benzler, by contrast, is directed to an external camera that determines the position of the robotic vehicle and calculates driving instructions based on a non-submerged swimmer that has a contrasting color from the water surface. Ex. 1013, Abstract. Neither Schnittman nor Benzler describes an underwater camera. And a POSITA would not have found it obvious in view of Schnittman and Benzler to employ a camera underwater, particularly when neither reference provides any technical guidance as to how that could be accomplished and Benzler even concedes that its system cannot overcome the singular impact of a “reflecting water surface” to even locate the robot cleaner when submerged, and must rely on the contrast between the color of the non-submerged swimmer and the water surface. Ex. 1013, [0029]. Additionally, as I have explained above, utilizing a camera underwater for debris-detection presents a host of challenges that would not have had obvious solutions, nor come with any reasonable likelihood of success for such (a) combination(s).

178. Dr. Reinholtz superficially attempts to fill the clear deficiency of Schnittman and Benzler only disclosing terrestrial cameras, by stating that “[b]y the July 10, 2012 priority date of the ’191 Patent, the use of cameras in underwater environments was commonplace.” *See* Ex. 1010, ¶ 209. Dr. Reinholtz’s attempt is unconvincing and unsuccessful.

179. Dr. Reinholtz cites three references as purported evidence that “the use of cameras in underwater environments was commonplace.” But I understand that two of the references are not in the record (Ex. 1026 and Ex. 1028), and the SubjuGator paper (Ex. 1017) does not support his conclusion. The SubjuGator paper readily concedes that “[b]ecause underwater environments can pose many types of challenges for object identification such as varying luminosities, sunlight dissipation, particle noise, and occlusions, combinations of novel normalization, filtering techniques and color space models are developed to robustly extract relevant target information from the environment in real-time.” Ex. 1017, 7. Thus, the very reference that Dr. Reinholtz points to as support for his opinion that “the use of cameras in underwater environments was commonplace,” disproves his conclusion.

180. Furthermore, upon further examination of Dr. Reinholtz’s Subjugator reference, a POSITA would have immediately realized that the algorithms listed in the reference are for the purpose of visual tracking only. Additionally, the successful

application of their proposed imaging techniques relies heavily, if not entirely, on the ‘objects’ being tracked (green/red buoys and red pipes) to exhibit extreme color/contrast differences compared to the surrounding environment (faded monochromatic background), and the need to be fully viewable in natural or controlled illumination settings, thereby starkly separating them from the surrounding background. Any POSITA would have immediately realized that this is nowhere near synonymous with identifying and classifying debris types that might be found inside a pool. The implication is rather obvious, namely that even the proposed computer-vision algorithms require that the environment be “rigged” to guarantee the successful application of a complex set of algorithmic techniques. Such a constraint would have immediately indicated to a POSITA that locating and identifying debris (and not high-contrast multi-colored buoys and pipes) would represent a much larger challenge, requiring undue experimentation with uncertain outcomes and unpredictable levels of success.

181. Regardless of Wybotics’ failure to include Ex. 1026 in the record, I have reviewed the publication titled “Computer Vision Applications in the Navigation of Unmanned Underwater Vehicles” (Ex. 1026; refiled as Ex. 2023) at the URL that Dr. Reinholtz cited. Ex. 1010, ¶ 84; *see also* Ex. 1010, ¶ 209. Dr. Reinholtz claims that “Computer Vision Applications in the Navigation of Unmanned Underwater Vehicles” is evidence that “[b]y the July 10, 2012 priority

date of the '191 patent, the use of cameras in underwater environments was commonplace.” Ex. 1010, ¶ 209. However, Dr. Reinholtz is incorrect, as this publication is evidence that the use of cameras was **not** commonplace. “Computer Vision Applications in the Navigation of Unmanned Underwater Vehicles” provides a twenty-two-page exposé on how and why “[t]he characteristics of the underwater environment pose a plethora of difficult challenges for vehicle navigation and these obstacles differ greatly from the issues encountered in land, air and space-based navigation.” Ex. 1026, 195 (refiled as Ex. 2023, 195). The use of computer vision in the varying applications is substantially different from an outdoor pool, which is a shallow-water environment, for all the reasons cited before, including uncontrollable and dynamically varying illumination, understanding and identification and classification of submerged surface debris due to light-reflection/-refraction and dynamic shadowing due to lighting-source, infrastructure, floating-debris, and surface-wave-shadowing.

182. Tellingly, the Petitions do not rely on any of the references that Dr. Reinholtz cites as part of any invalidity ground. Additionally, the Petitions do not even incorporate Dr. Reinholtz’s arguments drawn from this reference, as it does throughout the rest of the Petition. The Petitions merely include a single cite to this paragraph in a conclusory sentence. '191 Patent Petition at 57 (“Accordingly, Schnittman in view of Benzler renders obvious the claimed ‘at least one camera

[camera 1190] positioned on or in the body for capturing an image of at least a first portion of the submerged surface.’ *Id.*, ¶¶207-210.”). This is in stark contrast to the nearly verbatim copy-and-paste between Dr. Reinholtz’s declaration and the Petitions.

183. Therefore, Schnittman in view of Benzler does not render obvious “at least one camera positioned on or in the body for capturing an image of at least a first portion of the submerged surface.”

**4) Schnittman in view of Benzler does not render obvious “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”**

184. Claims 1–3 of the ’191 Patent, claims 1–5 of the ’766 Patent, and claim 1 of the ’207 Patent require “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”

185. The Petitions and Dr. Reinholtz concede that “Schnittman does not disclose the generation of control signals for causing movement ‘within the swimming pool’ and toward a portion of a ‘submerged [underwater] surface.’” Ex. 1010, ¶ 219; *see also* Ex. 1010, ¶¶ 329, 492; ’191 Patent Petition at 62; ’766 Patent Petition at 62; ’207 Patent Petition at 62. I agree.

186. But the Petitions and Dr. Reinholtz also assert that “a POSA would have understood, in view of Benzler, how to adapt Schnittman’s autonomous robotic cleaners for use in this context.” Ex. 1010, ¶ 219; *see also* Ex. 1010, ¶¶ 329, 492; ’191 Patent Petition at 62; ’766 Patent Petition at 62; ’207 Patent Petition at 62. I disagree.

187. In my opinion, the combination of Schnittman in view of Benzler does not render obvious “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface” because Schnittman’s image-based movement disclosure concerns a terrestrial robotic cleaner, while Benzler’s pool embodiment concerns external visual tracking of a swimmer situated above the surface of the water for trajectory following—not movement in response to an image of a first portion of a submerged pool surface.

188. Schnittman’s camera embodiment states that “the microprocessor 245 can process the signal from the camera 1190 to recognize debris on the cleaning surface and maneuver the robot 11 toward the debris. Additionally or alternatively, the microprocessor 245 can process the signal from the camera 1190 to recognize obstacles and/or debris in the vicinity of the robot 11 and maneuver the robot 11 to avoid obstacles and/or debris larger than a specific size threshold (e.g., a value less than about the smallest opening defined by the cleaning head).” Ex. 1008, [0204]–

[0205]. However, those disclosures concern movement over a terrestrial cleaning surface, not movement of a body within a swimming pool to or away from a first portion of a submerged surface. For example, Schnittman specifically describes adjustments being necessary for surfaces including carpet and hardwood floors. Ex. 1008, [0161]. But Schnittman does not mention adjusting for submerged surfaces. This is because, a POSITA would have understood that submerged surfaces cannot be treated as being in the same application-field as terrestrial surfaces. A multitude of factors and complications arise when dealing with submerged surfaces that are not present for terrestrial surfaces, including at least visibility challenges, which I have discussed at length above, waterproofing and moisture-sealing electronics, difficulties with traction and mobility, buoyancy of the robot, suspension of debris, pool-obstacles (water-intake grilles, lights, ladders, steps, etc.), fluid-dynamic resistance (center-of-thrust vs. center-of-drag vs. center-of-buoyancy, etc.), and particularities related to vehicle operation in a water environment. Accordingly, Schnittman only contemplates its invention being used for terrestrial surfaces. *See e.g.*, Ex. 1008, [0003], [0161], [0248].

189. Benzler does not supply the missing disclosure. Benzler's pool embodiment provides a camera arranged above the water surface for optical detection of a swimmer above the surface of the pool carried with the robotic vehicle by a guiding rod. Ex. 1013, [0029]. Benzler explains that, because the swimmer color

differs from the water surface, the logic unit can determine the position of the swimmer and therefore of the robotic vehicle. Ex. 1013, [0031]. That use of image data identifies the robot's position and orientation, not a dirty or clean first portion of the submerged pool surface that the robot should move towards or away from.

190. Benzler's trajectory-generation and -following disclosures confirm this distinction. Benzler describes a trajectory calculated by the logic unit based on distance information to an external border determined from the camera image data, with the robot driving ring tracks and shifting to adjoining tracks after each round. Ex. 1013, [0055]–[0056]. Those disclosures are about global coverage and border-relative trajectory-planning and -following, not about generating a control signal in response to an image of a first portion of a submerged surface to move the body to or away from that portion.

191. The Petitions and Dr. Reinholtz appear to combine different pieces of Schnittman and Benzler without identifying what pieces would be combined, what the technical steps required for such a combination would be, what the chance of success for these combinations would be, nor how the resulting system would meet the specific claim language. For example, the Petitions and Dr. Reinholtz rely on Schnittman's camera 1190 and microprocessor 245 to argue that image-based recognition of debris can cause movement toward debris or away from large debris. Ex. 1010, ¶¶ 215–219; *see also* Ex. 1010, ¶¶ 325–329, 488–492; '191 Patent Petition

at 60–63; '766 Patent Petition at 60–63; '207 Patent Petition at 60–62. The Petitions and Dr. Reinholtz then rely on Benzler for the proposition that Schnittman could be adapted for pool use. Ex. 1010, ¶¶ 219; *see also* Ex. 1010, ¶¶ 329, 492; '191 Patent Petition at 62; '766 Patent Petition at 62; '207 Patent Petition at 62. But the Petitions and Dr. Reinholtz do not identify where the combined system would capture an image of a first portion of a submerged pool surface and then generate a control signal that moves the body within the pool to or away from that same portion.

192. The asserted combination also leaves unresolved which controller and which captured image supposedly satisfy the claim. If the Petitions and Dr. Reinholtz rely on Schnittman's onboard camera and microprocessor, then the relied-on disclosure is directed to movement over a terrestrial (non-submerged) surface and does not describe a swimming-pool or submerged-surface as required by the claim. If the Petitions and Dr. Reinholtz instead rely on Benzler's pool embodiment, then Benzler's camera is above the water and detects the non-submerged swimmer for position tracking by identifying the contrast between the color of the swimmer and the water surface, rather than capturing a first portion of the submerged pool surface and generating a control signal to move to or away from that portion. Neither path describes the claimed controller limitation.

193. A POSITA would also have recognized that adapting Schnittman's camera-based debris response to an underwater pool cleaner would require

additional technical steps not supplied by Benzler. Schnittman's camera disclosure would need to be transformed from recognizing debris or obstacles on a terrestrial surface to identifying a spatially defined portion of a submerged pool surface with potential presence of debris or obstacles, determining that portion's location relative to the robot, and generating underwater movement commands relative to that portion—none of the required (technical) steps for such a combination and adaptation are provided in either the Petitions or Dr. Reinholtz's Declaration. As I pointed out earlier in my section on the Background of the Technology, achieving even just a limited capability of detecting and classifying floor-located obstacles in indoor environments, and then only based on a very large training set of a severely limited and specific set of obstacles, was not achieved reliably by iRobot, one of the leaders in the development of indoor floor-cleaners and the assignee of Schnittman, until at least nine (9) years after the priority date of the Challenged Patents. Benzler's pool embodiment instead tracks a non-submerged surface-floating swimmer by identifying the contrasting color of the swimmer against the water's surface to determine vehicle position and orientation, and calculates coverage trajectories, and therefore does not provide the missing image-to-surface-portion mapping needed for the claimed "to, or away from" movement.

194. Dr. Reinholtz's analysis likewise does not bridge the gap. He states that "Schnittman's camera depicts a portion of the cleaning surface [], and the

microprocessor processes the image to recognize debris in the image,” and then “[b]ased on the recognized debris in the image, the microprocessor generates control signals for moving the robot toward or away from the portion of the cleaning surface having the recognized debris.” Ex. 1010, ¶ 218; *see also* Ex. 1010, ¶ 328, 491. But then, he states that, “[w]hile Schnittman does not disclose the generation of control signals for causing movement ‘within a swimming pool’ and toward a portion of a ‘submerged [*i.e.*, underwater] surface,’ specifically, a POSA would have understood, in view of Benzler, how to adapt Schnittman’s autonomous robotic cleaners for use in this context.” Ex. 1010, ¶ 219; *see also* Ex. 1010, ¶ 329, 492. That reasoning assumes the conclusion; it does not identify a disclosure in Benzler that converts Schnittman’s terrestrial debris response into the claimed controller response to an image of a first portion of a submerged pool surface. It also fails to address the challenges associated with underwater imaging and debris-detection, -identification, and -classification, and the fact that Benzler teaches away from implementing a camera underwater on the pool robot. Ex. 1013, [0010].

195. Therefore, Schnittman in view of Benzler does not render obvious “a controller ... configured to generate, in response to the captured image, at least one control signal to cause movement of the body within the swimming pool to, or away from, the first portion of the submerged surface.”

**5) Schnittman in view of Benzler does not render obvious “one or more cameras configured to capture video or images of**

**at least a portion of a location including the swimming pool or spa, wherein the controller is remote from the camera.”  
(’207 Patent, Claim 11)**

196. As discussed above, in my opinion a POSITA would not be motivated to modify Schnittman based on Benzler. Further, claim 11 of the ’207 Patent requires that the controller is remote from the camera. While this may be disclosed by Benzler, this is the opposite of what Schnittman teaches. The Petition and Dr. Reinholtz argue that a POSITA would have been motivated to “implement[] Benzler’s external camera 8 with Fu’s onboard controller.” ’207 Patent Petition, 68–69; Ex. 1010, ¶ 520. However, neither the Petition nor Dr. Reinholtz provide explanation of how a POSITA would have successfully modified Schnittman with Benzler’s exterior imaging system that tracks the location of a non-submerged swimmer and cannot image the submerged surface of the pool. If Dr. Reinholtz’s argument implies removal of the camera from Schnittman, such a step would be counter to the entire concept described in Schnittman, as discussed above. Schnittman states that, “in some implementations, the robot 11 includes a camera 1190 disposed toward the forward portion of the robot 11, with a field of view beyond the perimeter of the robot 11. This camera 1190 can be in communication with the microprocessor 245.” Ex. 1008, [0204]. Schnittman then illustrates microprocessor 245 as being part of the robot in Figure 12A. Ex. 1008, Fig. 12A. Benzler’s camera, however, as discussed above, is not configured to capture images

of the bottom of the pool, and instead must track the location of the pool robot via a swimmer traveling along the surface of the pool. Even if Dr. Reinholtz were to argue that the combination of Schnittman with Benzler were to use both the cameras and controllers of Schnittman's terrestrial robot (despite all the uncertainties and complications of its adaptation to an underwater use) and Benzler's pool-external camera and controller, and seeing as the Petitions and Dr. Reinholtz never even provide any technical detail for such a combination, a POSITA would be dissuaded from such a combination, as such a combination would (i) at minimum require a completely new and more complex multi-processor controller architecture, (ii) bring with it challenges in data-transmission bandwidth and latency which would greatly impact operational effectiveness and efficiency, (iii) require non-trivial re-engineering steps to adapt an in-air terrestrial robot platform to underwater usage, (iv) pose substantial underwater computer-vision algorithm development challenges for all the reasons cited earlier, and (v) yield a system that is operationally cumbersome (if not impractical), given that the submerged robot is required to operate with a pole-mounted swimmer and antenna. A POSITA would have realized that such a combination would not have been advantageous nor have a clear and certain path to technical implementation success. Therefore, the Petition and Dr. Reinholtz do not explain how or why a POSITA would have found it obvious to modify Benzler's external camera that cannot image the submerged surface with

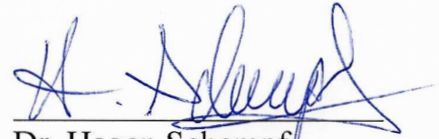
Schnittman's controller, nor how a combination of Schnittman's terrestrial floor-cleaner camera and/or controller would work with Benzler's pool-external camera nor controller.

## **IX. Conclusion**

197. For the reasons I explain above, it is my opinion that none of the claims addressed above are anticipated or rendered obvious as asserted in the Petitions and Dr. Reinholtz's declaration.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are 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.

Executed on 08-11, 2026 in MIAMI BEACH, FL.

  
Dr. Hagen Schempf