

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

BEATBOT TECHNOLOGY (USA) CO. LTD.,

Petitioner,

v.

ZODIAC POOL SYSTEMS LLC,

Patent Owner.

PTAB Case No. IPR2026-00201

U.S. Patent No. 11,880,207 B2

**DECLARATION OF DR. JASON A. JANÉT IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 11,880,207 B2**

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EXHIBIT LIST

No.	Exhibit
1001	U.S. Patent No. 11,880,207 (“’207 Patent”)
1002	File History of the ’207 patent (“’207FH”)
1003	[Reserved]
1004	Curriculum Vitae of Jason Janét, Ph.D.
1005	Chinese Patent Application Publication No. CN1540119A (“Cui”)
1006	German Patent Application Publication No. DE102007053310A1 (“Knoll”)
1007	Chinese Patent Application Publication No. CN101139007A (“Fu-007”)
1008	U.S. Patent No. 3,321,787 (“Myers”)
1009	U.S. Patent No. 4,168,557 (“Rasch”)
1010	Jonathan Horgan & Daniel Toal, Review of Machine Vision Applications in Unmanned Underwater Vehicles, Proc. 9th Int’l Conf. on Control, Automation, Robotics and Vision 1 (2006)
1011	U.S. Patent Application Publication No. 2013/0024025 A1 (“Hsu”)
1012	U.S. Patent Application Publication No. 2008/0048870 A1 (“Laitta”)

LISTING OF CHALLENGED CLAIMS

11,880,207
Claim 1
1[pre] A self-propelled pool cleaning system for cleaning debris from a submerged surface of a swimming pool, comprising:
1[a] a. a vehicle body;
1[b] b. means for moving the vehicle body within the swimming pool;
1[c] c. a filter configured to retain debris collected from the submerged surface;
1[d] d. at least one camera for capturing an image of at least a first object within the swimming pool; and
1[e][i] e. a controller (i) in electronic communication with the at least one camera and
1[e][ii] (ii) 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.
Claim 2
2[pre] A pool system comprising:
2[a] at least one piece of equipment for a swimming pool or spa;
2[b] one or more cameras configured to capture video or images of at least a portion of a location including the swimming pool or spa; and
2[c][i] a controller in communication with the at least one piece of equipment and the one or more cameras,

2[c][ii] the controller configured to receive visual data from the one or more cameras and determine a control action for the at least one piece of equipment based on the received visual data.
Claim 3
3. The pool system of claim 2, wherein the at least one piece of equipment comprises a cleaning device with one or more propulsion mechanisms, the cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation.
Claim 5
5. The pool system of claim 2, wherein the one or more cameras are mounted on the at least one piece of equipment.
Claim 6
6. The pool system of claim 2, wherein the one or more cameras are submersible or submerged within the swimming pool or spa.
Claim 7
7. The pool system of claim 2, wherein the controller is configured to detect a characteristic of the location based on the visual data and control the piece of equipment based on the detected characteristic.
Claim 8
8. The pool system of claim 7, wherein the characteristic comprises a cleanliness of a surface of the swimming pool, and wherein the controller is configured to control the piece of equipment based on the detected cleanliness being outside of a threshold.
Claim 10

10. The pool system of claim 2, wherein the controller is further configured to present a graphical depiction on a remote device based on the received visual data as the control action.
Claim 12
12[pre] A method for monitoring a pool system, the method comprising
12[a] receiving images of at least a portion of a location including a swimming pool or spa from one or more cameras;
12[b] determining a target area and detecting a characteristic of the target area based on the images; and
12[c] generating a control response based on the detected characteristic of the target area.
Claim 13
13[a] The method of claim 12, wherein the target area comprises a portion of a surface of the swimming pool or spa, and
13[b] wherein the characteristic comprises a cleanliness characteristic of the portion of the surface of the swimming pool or spa.
Claim 14
14. The method of claim 12, wherein generating the control response comprises controlling an operation of a piece of equipment of the swimming pool or spa.
Claim 15
15. The method of claim 12, wherein generating the control response comprises generating an alert on a remote device.
Claim 16

16. The method of claim 12, wherein generating the control response comprises wirelessly communicating with a piece of equipment for the swimming pool or spa or a remote device.

Claim 17

17. The method of claim 12, wherein generating the control response comprises prompting a user on a remote device, and wherein the method further comprises receiving a control input from the user on the remote device for controlling a piece of equipment of the swimming pool or spa.

Claim 19

19[a] The method of claim 12, wherein generating the control response comprises controlling operation of a cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation,

19[b] wherein controlling operation of the cleaning device comprises one or more of controlling a path or route of the cleaning device, an aggressiveness of cleaning chemicals deployed, an aggressiveness of mechanical cleaning, or a speed of the cleaning device.

I, Jason A. Janét, of Raleigh, North Carolina, declare that:

I. INTRODUCTION

1. I have been retained by counsel for Petitioner BEATBOT TECHNOLOGY (USA) CO. LTD. (“Petitioner” or “BEATBOT”) as an expert witness to provide my opinion regarding certain prior art references and U.S. Patent No. 11,880,207 (“the ’207 Patent”) in their Petition for *Inter Partes* Review.

2. I make this declaration based upon my own personal knowledge and, if called upon to testify, will testify competently to the matters stated herein.

3. I have been asked to provide my expert opinion in connection with the *Inter Partes* Review of the ’207 Patent to Durvasula *et al.* concerning whether it is unpatentable over certain prior art. This declaration is a statement of my opinions on issues relating to the patentability of claims 1-3, 5-8, 10, 12-17, and 19 (the “Challenged Claims”) of the ’207 Patent. As I explain more fully below, it is my opinion that all of the Challenged Claims would have been obvious to a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention.

4. I am being compensated for my work in this matter at my standard hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My compensation is not contingent on the outcome of this matter or the specifics of my testimony.

5. I understand that the '207 patent has been assigned to Zodiac Pool Systems LLC.

6. This declaration is based on the information currently available to me. To the extent that additional information becomes available, I reserve the right to continue my investigation and study, which may include a review of documents and information that may be produced, as well as testimony from depositions that have not yet been taken.

A. Qualifications and Professional Experience

7. I have studied, taught, and practiced in the field of robotics for over thirty years, including extensive work in autonomous underwater vehicles, camera-based sensing systems, and computer vision applications. I have a Ph.D. in Electrical & Computer Engineering from North Carolina State University (or "NCSU"), which I earned in 1998. Prior to that I received a M.S. in Integrated Manufacturing Systems Engineering from North Carolina State University in 1994 and a B.S. in Mechanical Engineering from the University of Virginia in 1990.

8. Since 1991, I have been active in the submersible and land-based mobile robots, wall-climbing mobile robots, sensors, pattern analysis, computer vision, image/video processing, and automation fields. My work has specifically included developing autonomous systems that use camera-based image analysis to

detect objects, recognize surface characteristics, and make control decisions. I have authored numerous publications and have co-authored a textbook entitled *Computational Intelligence*.

9. My PhD dissertation is entitled *Pattern Analysis, Tracking and Control for Autonomous Vehicles Using Neural Networks*. It described the use of unsupervised training (i.e., the Hyper-Ellipsoid Clustering Neural Network, or “HECNN”), and supervised training (i.e., the Region-Feature Neural Network, or “RFNN”) for dissimilar mobile robots to learn aspects of their common environments through multiple types of sensors (e.g., imaging, acoustic rangefinding, infrared proximity, and tactile), and then transfer knowledge between for operational use and/or refinement. Among other outputs, the robots learned to recognize surface conditions, spaces, objects and landmarks within those spaces, and then plan and track motion from the accumulated and shared knowledge. The robots demonstrated the ability to use visual and sensor data to autonomously recognize and respond to environmental characteristics.

10. I have designed, built, and marketed robots, automated systems, and components thereof, including submersible and ground mobile robots, unmanned aerial vehicles (UAV), unattended sensors automated storage and retrieval systems (ASRS), proof-of-concept extra-terrestrial robots, manually manipulated

(“twiddled”) submersible foils, wall climbing mobile robots, and augmented reality systems.

11. I have taught the following courses: Introduction to Robotics and Automation (Duke and NCSU); Introduction to Control Theory (Duke and NCSU); Distributed Real-Time Controls (NCSU); and myriad independent studies courses in the areas of robotics, automation, artificial intelligence, autonomy, pattern analysis, and control systems. I have also served on several MS- and PhD-level graduate student committees, designed qualifying exam problems, served on the NCSU IMSEI Board, and participated in curriculum development for undergraduate and graduate level programs.

12. I have also started, sponsored, and advised multiple champion student teams for international robot competitions including, but not limited to, the NASA/ASCE Extra-Terrestrial Robotics Competition, the DARPA Grand Challenge, the AUVSI/ONR Autonomous Underwater Vehicle Competition, and the European CLAWAR Wall-Climbing Robot competition.

13. I have initiated multiple unmanned aerial vehicle (UAV) projects at both academic and industry levels. The AngelFish Cross-Domain Submersible UAV, a DARPA ASW program that I incubated and procured funding for at Teledyne, included a partnership with North Carolina State University. Additionally,

academic UAVs include, but are not limited to, Quadcopters with Hybrid Remote and Autonomous Control, Marsupial UAVs that Deploy and Recover Unmanned Ground Vehicles, and Wall-Climbing UAVs.

14. In 1999, while I was employed by Nekton Research (“Nekton”), I captured and managed multiple programs sponsored by the Department of Defense (DoD) and private-sector companies that focused primarily on autonomous underwater vehicles (AUV), remotely operated vehicles (ROV), TwiddleFish toys, and indirect-fire projectiles. During my tenure, Nekton entered into a joint venture agreement with the founders of what eventually became known as Parata Systems – a pharmacy automation solutions company, which I supported launching.

15. After leaving Nekton in March 2002, I joined a then New Jersey-based company called Avionic Instruments, Inc. (“Avionic”). While at Avionic, I continued developing and marketing robots and supported engineering related to various design, manufacturing, quality and assembly issues on the core aerospace product lines. Avionic product lines include, but are not limited to, ducted fans, transformer rectifier units (TRU), regulated TRU (RTRU), auxiliary power unit (APU) control systems, power distribution systems (PDU), frequency converters, corner clamps, and VRAM attractors/thrusters. Customers included DoD, NASA, Boeing, Sikorsky, Augusta-Westland, Dassault, and Lockheed-Martin.

16. In late 2004, soon after Avionic was sold, I, along with others from Avionic, secured funding to develop an alpha-level multi-dispenser robotic system which afforded me time to write the RxMedic business plan and raise multiple rounds of venture capital. In late 2006, RxMedic (called “APDS” until November 2006) was launched as a stand-alone, sole-focus venture. After the operational launch of RxMedic, I served as General Manager and eventually Chief Technical Officer. Through my roles at RxMedic, I oversaw the development of the RxMedic ADS robot, managed the intellectual property portfolio, coordinated sales and marketing, and provided strategic, fiscal, and operational leadership. In May 2010, J.M Smith Corporation acquired RxMedic, and in an effort to assist in the change of ownership, I served as a director of RxMedic until May 2011.

17. Also in late 2004, after Avionic was sold, I, along with others from Avionic, secured funding for Vortex HC through DoD contracts and robot sales, to continue developing the VRAM Mobile Robot Platform (VMRP – a wall-climbing robot), the ARTEMIS AUV (a holonomic submersible robot for counter-mine and counter-obstacle operations), the submersible crawler, the nuclear-grade boiler water reactor (BWR) inspection robot, and other robot products centered around the VRAM. Some DoD programs were/are classified, for which I maintained a SECRET clearance at both the personal and facilities level, and served as the facilities security

officer (FSO). In late 2006, corresponding to the full launch of RxMedic, Vortex HC technologies were largely licensed to Teledyne SeaBotix, SeaRobotics, and HDT. However, I have continued to support Vortex HC licensees and customers to date. After the sale of RxMedic, and after fulfilling my 12-month employment obligation, I joined Teledyne Technologies in summer 2011. I served as the Senior Manager for the RTP division of Teledyne Scientific, and supported multiple DoD sponsored robotic-focused programs. Some of these programs were/are classified, for which I maintained a personal SECRET clearance. Among these programs, were cargo unmanned ground vehicles (CUGV), squad-level autonomous unmanned ground vehicles (UGV), autonomous underwater vehicles (AUV), unmanned underwater vehicles (UUV), and a cross-domain autonomous vehicle capable of transitioning between air-, surface- and underwater-domains. Cross-domain vehicles that were evaluated, designed and prototyped included, but were not limited to, the AngelFish (later called “EagleRay”) submersible AUV for anti-submarine warfare, and a ball-shaped robot for countermine operations on the ground, in the beach zone and in the surf zone. Sensor design, refinement and signal processing was a major component of each program. Sensors employed include, but are not limited to: proximity sensors; ranging sensors; electro-optical imaging; long-, short- and mid-wave infrared (IR); inertial measurement units (IMU); optical flow; and radiofrequency (RF).

Additionally, control systems were designed, refined and integrated into the aforementioned systems. Most control systems were closed-loop, in that they utilized sensor-based feedback; others were open-loop, where states were estimated with little or no feedback.

18. In late 2013, Avionic, a Transdigm business unit at that point, requested that I return to turn around a supply-chain issue, and assume management of its Sikorsky S97 Raider helicopter program. The S97 Raider is purported to be the fastest, most maneuverable helicopter, due to its coaxial, counter-rotating variable pitch wings, and an aft-based push-propeller. Avionic also controlled two business units named Acme Aerospace (Acme) and Aerospace Cooling Solutions (ACS). Avionic, Acme and ACS supported the S97 program, which has met milestones and continues to produce multiple successful demonstrations. In 2013, Transdigm expanded my role to include directorship of the Avionic, Acme and ACS sales and marketing team, and to report operational and financial status at six-week intervals. Transdigm required that I move my family to New Jersey in late 2014, which influenced my decision to resign and assume the CEO role of Delta Five Systems in Raleigh, NC.

19. As CEO of Delta Five, I led a private-equity backed, hospitality-focused venture, coordinating the company's launch and strategic path including an

early stage pivot. Initially focused on back-end robotics and automation, Delta Five shifted to address the rampant bed bug problem—a top priority for hoteliers—with a novel unattended sensor and trap, called the Telemetered Pest Monitoring System (TPMS), which is based on computer vision and internet of things (IoT), and has proven capable of scaling to other pests. In addition to the TPMS, Delta Five developed a novel means to mass produce a natural, unscented aggregation pheromone that, in concert with placement and heat, lured invertebrates to the TPMS. After leading Delta Five and serving on its Board for four years, I resigned to join ARA, but continue serving Delta Five as an investor and supportive transition agent.

20. In 2018, I joined ARA as sector CTO. In this role, my primary responsibilities included leading the commercialization and technology transition efforts, which require technical, business and corporate development, as well as the raising of capital and managing matrixed rosters. I assumed my other current role at ARA, Corporate Director of IP and Product Commercialization, in 2020. In this role, I evaluate, quantify, present, and recommend portfolios of IP, product lines, and ventures on the basis of competitive landscapes, addressable markets, sales strategy, resource availability and technology readiness. I also spearhead investments and provide general venture oversight. I maintain active TOP SECRET and SCI (Sensitive Compartmented Information) security clearances.

21. My curriculum vitae is attached as EX1004 to this declaration in support of the IPR petition, and provides further information about my experience, expertise, and presentations.

22. Considering the foregoing, I consider myself to be an expert in the field of autonomous underwater robotics, including camera-based computer vision, image processing for object and surface recognition, autonomous control systems, and robotic operation in aquatic environments such as pool cleaning and monitoring systems. Therefore, I believe that I am qualified to provide an opinion as to what a person of ordinary skill in the art at the time of the invention (“POSITA”) would have understood, known, or concluded regarding the subject matter of the ’207 patent involved in this case.

B. Materials Reviewed

23. My opinions expressed in this declaration are based on documents and materials identified in this declaration, including the ’207 patent, the prior art references and background materials discussed in this declaration, and the other references specifically identified in this declaration. I have considered these materials in their entirety, even if only portions are discussed here. The following is an exemplary list of the materials on which I based on opinion.

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1001	U.S. Patent No. 11,880,207 (“’207 Patent”)
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1003	[Reserved]
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1008	U.S. Patent No. 3,321,787 (“Myers”)
1009	U.S. Patent No. 4,168,557 (“Rasch”)
1010	Jonathan Horgan & Daniel Toal, Review of Machine Vision Applications in Unmanned Underwater Vehicles, Proc. 9th Int’l Conf. on Control, Automation, Robotics and Vision 1 (2006)
1011	U.S. Patent Application Publication No. 2013/0024025 A1 (“Hsu”)
1012	U.S. Patent Application Publication No. 2008/0048870 A1 (“Laitta”)

24. In forming the opinions expressed below, I have considered:

- the documents listed above;
- the relevant legal standards as explained to me by the Petitioner’s counsel, including the standard for obviousness, and any

additional authoritative documents as cited in the body of this declaration;

- my own knowledge and experience based upon my work in the field of underwater robotics as described above; and
- any other documents not listed above but cited below.

25. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

26. My analysis of the materials produced in this proceeding 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.

27. Unless otherwise noted, all emphasis in any quoted material has been added.

II. LEVEL OF ORDINARY SKILL IN THE ART

28. My analysis reflects the views of a person of ordinary skill in the art (POSITA) in the field of the '207 Patent as of July 10, 2012, which I understand is

the alleged time of invention.

29. I have been advised by the Petitioner's counsel and understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems. I understand that POSITAs is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that POSITAs would also have knowledge from teachings of the prior art, including the art cited below.

30. Taking these factors into consideration, in my opinion, on or before July 10, 2012, POSITAs would have been someone knowledgeable and familiar with design or development of autonomous robotic systems, camera-based sensing and image processing, and control systems for aquatic or underwater applications that are pertinent to the '207 Patent. That person would have a bachelor's degree in electrical engineering, mechanical engineering, physics, or computer engineering, with at least two years' experience in autonomous camera-based robotic cleaning systems. In my opinion, a lack of work experience can be remedied by additional education, and vice versa.

31. As of July 10, 2012, I met, and in fact exceeded, the qualifications of a person of ordinary skill in the art.

32. For purposes of this Declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my experience and the understanding of POSITAs generally (and specifically related to the references I consulted herein), reflect the knowledge that existed in the field as of the earliest possible priority date of the '207 Patent (i.e., July 10, 2012). Unless otherwise stated, when I provide my understanding and analysis below, it is consistent with the level of POSITAs prior to the earliest alleged priority date of the '207 Patent.

III. RELEVANT LEGAL STANDARDS

33. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the '207 Patent, I am relying on certain basic legal principles that counsel have explained to me. These principles are discussed below.

34. I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious in view of what was known before the invention was made.

35. I understand the information that is used to evaluate whether an invention is new and not obvious is generally referred to as “prior art” and generally includes patents and printed publications (e.g., books, journal publications, articles

on websites, product manuals, etc.).

36. I understand that in this proceeding Petitioner has the burden of proving that the claims of the '207 Patent are anticipated by or obvious in view of the prior art by a preponderance of the evidence. I understand that “a preponderance of the evidence” is evidence sufficient to show that a fact is more likely true than it is not.

37. I understand that prior art to the '207 Patent in this proceeding includes patents and printed publications in the relevant art that predate the proper priority date of the alleged invention recited in the '207 Patent.

38. I understand that terms appearing in the patent claims are to be interpreted according to their “ordinary and customary meaning” in an IPR proceeding. In determining the ordinary and customary meaning, the words of a claim are first given their plain meaning as they would have been understood by POSITAs at the time of the alleged invention, in light of the specification and file history. I understand that treatises and dictionaries may be consulted, albeit under limited circumstances, to determine the meaning attributed by POSITAs at the time of the alleged invention. I have followed this approach in my analysis and have applied the ordinary and customary meaning of those terms throughout my analysis in this Declaration.

39. I understand that there are two ways in which prior art may render a

patent claim unpatentable. First, the prior art can be shown to “anticipate” the claim. Second, the prior art can be shown to have made the claim “obvious” to a person of ordinary skill in the art. In this declaration I focus on “obviousness.” My understanding of the legal standard for “obviousness” is set forth below.

40. I have been informed by counsel that a claimed invention is unpatentable as obvious if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. I have also been informed by counsel that the obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

41. Specifically, I understand that the obviousness question requires consideration of four factors (although not necessarily in the following order):

- The scope and content of the prior art;
- The differences between the prior art and the claims at issue;
- The knowledge of a person of ordinary skill in the pertinent art;
- and
- Whatever objective factors indicating obviousness or non-

obviousness may be present in any particular case.

42. I have been informed by counsel that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. I also understand that, at least in IPR proceedings, admissions in the patent or in the prosecution file history of the patent (referred to as Applicant Admitted Prior Art or “AAPA”) can be used to, among other things, establish background knowledge possessed by POSITAs.

43. I further understand that certain factors may support or rebut the obviousness of a claim. I understand that such secondary considerations include,

among other things, commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of invention, unexpected results of the invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I understand that there must be a nexus—a connection—between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

44. I am not aware of any allegations by the named inventor of the '207 Patent or any assignee of the '207 Patent that any secondary considerations are relevant to the obviousness analysis of any Challenged Claim of the '207 Patent.

45. I understand that a petition must identify, for any terms with means-plus-function limitations, the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function. I also understand a rebuttable presumption exists that without use of the term, “means,” a claim term is not interpreted as means-plus-function, but that other nonce words like “component” have been found to satisfy the rebuttable presumption and invoke a means-plus-function claim construction of such a claim term.

46. I also understand that a petitioner seeking to demonstrate that the prior art discloses a means-plus-function limitation must prove that the corresponding structure—or an equivalent—was present in the prior art and performing the same claimed function.

47. I understand that the standard for determining whether the prior art discloses the corresponding structure or an equivalent is whether there are insubstantial differences, which means that if the assertedly equivalent structure performs the claimed function in substantially the same way to achieve substantially the same result as the corresponding structure described in the specification, it is equivalent.

48. I understand that proving structural equivalence does not require a component-by-component analysis, but rather that it is sufficient to show structure, materials, or acts that perform the claimed function in substantially the same way to achieve substantially the same result because the claim limitation is the overall structure corresponding to the claimed function and not individual components.

49. I understand that for a claim to be valid, its scope must be definite, and that improperly introducing a term can lead to an unascertainable scope of a term, rendering it indefinite. I understand that any claim element first addressed in the claims by the antecedent basis, “a” may then be identified later in the claims by the

antecedent basis, “the.” I understand that failing to follow this convention may lead to ambiguity in the identification of the particular claim element in question, leading to an indefinite scope of the claim’s term. For purposes of this proceeding, I identified and provided my best understanding of any such terms despite such ascertainable scope.

IV. SUMMARY OF OPINIONS

50. During my review, I have evaluated the claims of the challenged patents and it is my opinion that each challenged claim is invalid. Specific invalidity grounds are listed in the table below, where all the references are prior art under AIA 35 U.S.C. §102(a)(1)-(2).

Grounds under 35 U.S.C. §103	Claims	Reference(s)
1A	<u>1</u> , <u>2</u> , 3, 5-8, <u>12</u> , 13-14, 19	Cui
1B	8, 16	Cui and Fu-007
1C	10, 17	Cui and Hsu
2A	<u>1</u> , <u>2</u> , 3, 5-7, <u>12</u> , 14, 19	Knoll
2B	7-8, <u>12</u> , 13-14, 19	Knoll and Fu-007
2C	10, 17	Knoll, Fu-007, and Hsu
3	<u>2</u> , 4, 7, 10, <u>12</u> , 14-16	Laitta

51. I reserve the right to supplement these findings should new information

be made available.

V. OVERVIEW OF THE TECHNOLOGY

52. The following section summarizes the state of the art in the field of robotic pool cleaners as of the alleged July 10, 2012 priority date. The technical information and principles discussed herein were well-documented in the public domain and represent the common general knowledge available to a person of ordinary skill in the art (POSITA) at that time.

A. Historical Context: Stochastic Navigation in Early Pool Robotics (1967–2000)

1. The Genesis of the Submersible Chassis: Myers (1967)

53. The foundational architecture of the electric robotic pool cleaner was established by Robert B. Myers in U.S. Patent No. 3,321,787 (“Myers”; EX1008), titled “Swimming Pool Cleaning Means,” filed in 1967. Myers’ invention was significant not for its intelligence, but for its robust interaction with the aquatic environment. The patent describes a device that is “erratically self-propelled over the bottom surface of the swimming pool.” The operational principle was purely stochastic. The device utilized a drive mechanism that induced random turns and reversals. Statistically, given infinite time, a random walk within a bounded domain (the pool) will cover the entire area. However, in practical terms, this resulted in significant inefficiency. The “intelligence” of the Myers device was mechanical,

relying on physical interaction with pool walls to trigger directional changes. This established the “bump-and-turn” paradigm that would dominate the industry for decades.

2. The Rasch Architecture (1979)

54. The next quantum leap in mechanical design came from Wilhelm Rasch, whose work culminated in U.S. Patent No. 4,168,557 (filed 1976, granted 1979; EX1009). Rasch’s patent described the canonical form factor of the modern robotic cleaner:

- A sealed, waterproof body containing the drive motor and pump motor.
- A filter chamber located within the body.
- Endless tracks (caterpillar tracks) for traction on slippery pool liners.
- An impeller system that not only drew water through the filter but also created a thrust force perpendicular to the surface (pressing the cleaner against the floor or walls) to maintain traction, including on vertical walls.

B. The Rise of Underwater Computer Vision (Before 2012)

55. By the alleged July 10, 2012 priority date, the application of machine vision in the control of unmanned underwater vehicles (UUVs) was a well-established and rapidly maturing field. While early underwater navigation relied heavily on expensive and bulky acoustic sensors, the industry had shifted toward

machine vision because cameras provided a lightweight, inexpensive, and flexible alternative that lacked the minimum operating range limitations of sonar. By 2010, machine vision was already considered a “natural” inclusion in underwater control loops, serving as standard payload equipment for both autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs) to assist in tasks like inspection, surveying, and data collection.

56. For example, 2006 review paper by Jonathan Horgan and Daniel Toal, titled “Review of Machine Vision Applications in Unmanned Underwater Vehicles” (EX1010; “Horgan”) provides a comprehensive overview of the integration of machine vision in underwater robotics. As the authors note, by 2006, machine vision was already a standard sensor in underwater control loops, serving as a lightweight and cost-effective alternative to acoustic sensors. EX1010, p.1. They further note that because cameras were common payloads, they were “naturally” utilized within vehicle control loops to facilitate autonomous navigation and positioning. *Id.*

57. Horgan explicitly describes the closed-loop architecture required to move a vehicle in response to visual data. For instance, in “station keeping” applications, a vehicle uses a downward-facing camera to acquire images of the floor at a range of 1–3 meters. *Id.* The system’s controller then analyzes these captured images to measure the vehicle’s offset and automatically generates “appropriate

thruster signals” (i.e., control signals) to cause movement of the vehicle body to a specific orientation or position. *Id.*

58. Furthermore, Horgan details “target tracking” and “feature tracking” where the system is configured to move the vehicle body specifically toward or relative to a first object. *See id.* The paper describes methods where vision is used to “determine the required direction” to an object of interest, allowing the controller to steer the vehicle based on that identified direction. *Id.*, p. 4.

59. By the alleged July 2012 priority date, a POSITA would have recognized that these established underwater navigation techniques—using captured images to identify objects and generating control signals to guide the vehicle relative to those objects—were directly applicable to the environment of a self-propelled pool cleaner.

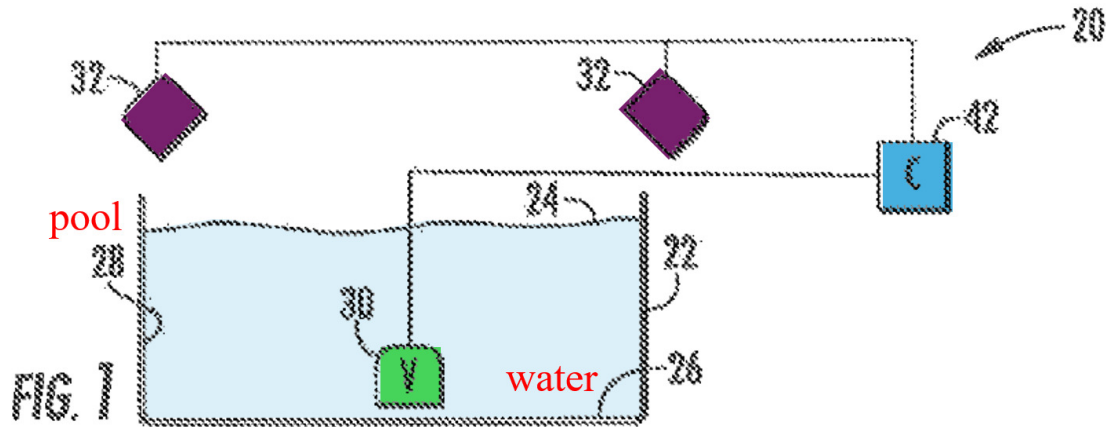
VI. THE '207 PATENT

A. Overview

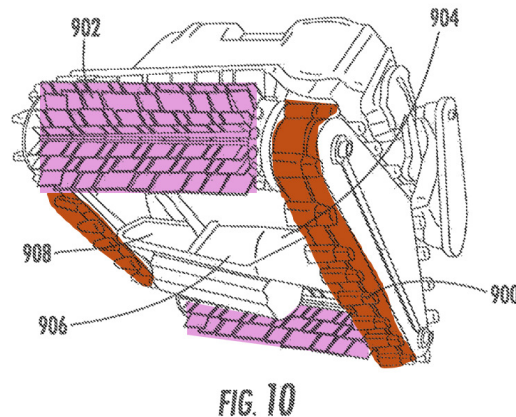
60. The '207 Patent describes a pool system that uses camera-based image analysis to detect pool conditions and generate control responses. EX1001, Abstract. As illustrated in FIG. 1 (annotated below), the system includes a “**camera 32**”¹

¹ All **bold**, *italic*, or colored emphases are added by Petitioner unless otherwise specified.

positioned to capture images of a swimming pool or spa, a “**controller 42**” that analyzes the images and generates control responses for pool equipment (e.g., **vehicle 30** for cleaning applications). EX1001, 2:64-5:9.



61. The system also includes a cleaning device (vehicle 30 as illustrated in FIG. 1 (annotated above)) with a body, a **drive system** coupled to the body for moving the body within the pool, and cleaning equipment (**brushes**, suction mechanisms, chemical dispensers) for removing debris. *Id.*, 10:11-30, FIG. 10 (annotated below). The cameras capture images of the pool, and the controller analyzes the images to determine the cleanliness of submerged pool surfaces and generates control signals to adjust the operation of the cleaning vehicle. *Id.*, 8:27-9:59.



B. Prosecution History

62. The '207 Patent claims priority to U.S. Patent Application No. 13/545,918 filed on July 10, 2012, which is assumed to be the priority date for all Challenged Claims for purposes of this Petition. EX1001, field (63).

63. The Examiner issued a Non-Final Office Action rejecting the sole pending claim (Claim 20) for nonstatutory double patenting. EX1002, pp.82-90. Applicant filed a Terminal Disclaimer and new Claims 21-39 (Claims 21 and 31 being independent claims). *Id.*, pp.92-105. The Examiner then allowed the claims.

64. Fu-007, used in this petition, was cited in an Information Disclosure Statement (IDS) (EX1002, pp.55, 72) but was not used as a basis for claim rejections or otherwise discussed during the prosecution. Fu-007's use in this Petition is not cumulative over the prior examination at least because Fu-007 is used in combination with other references, including Knoll and Cui, and the Examiner lacked expert testimony regarding the use of Fu-007 in combination with other

references.

C. Claim Construction

65. I have been advised by Petitioner’s counsel and understand that, for determining invalidity in this Petition, Petitioner believes no constructions are necessary except for the means-plus-function (MPF) limitation “means for moving the vehicle body” in Claim 1.

66. When a claim uses “means” or “module” and recites an associated function, it is presumably MPF. *See* pre-AIA 35 U.S.C. §112 ¶6; MPEP §2181; *TriMed, Inc. v. Stryker Corp.*, 514 F.3d 1256, 1259-60 (Fed. Cir. 2008).

67. Claim 1 recites a claim limitation in the form of “means for moving....” and recites a claimed function of “moving the vehicle body within the swimming pool.” EX1001, 10:50-64. It is my opinion that the corresponding structure described in the specification of the ’207 Patent includes: wheels, rollers, tracks, other surface contacting members powered by a motor, a vacuum, or a liquid jet. *Id.*, 3:33-45, 10:15-17, FIGS. 9-10.

68. In my opinion, the above described structures in the specification of the ’207 Patent are the corresponding structures for the “means for moving....”

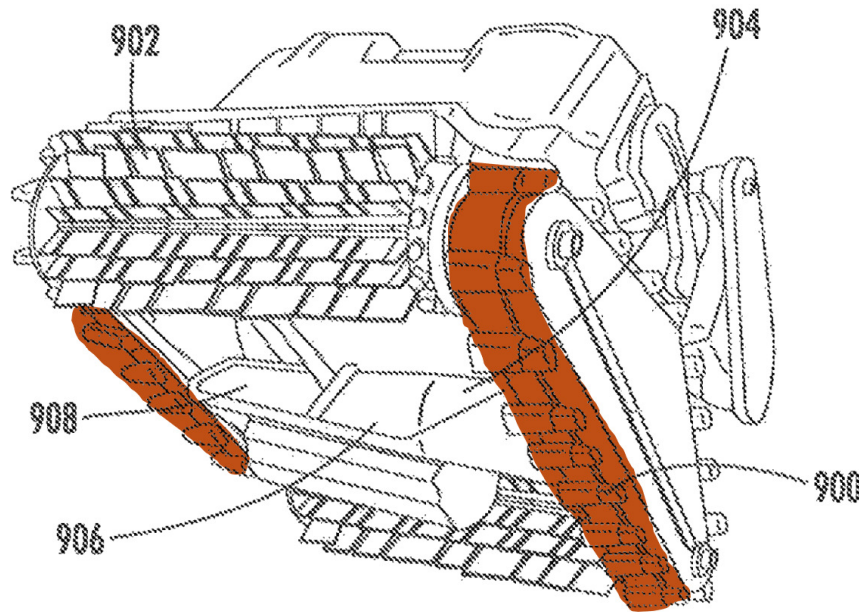


FIG. 10

VII. SPECIFIC GROUNDS

A. Ground 1A: Claims 1-3, 5-8, 12-14, and 19 are unpatentable over Cui

69. In my opinion, as explained below, Cui discloses or suggests Claims 1-3, 5-8, 12-14, and 19.

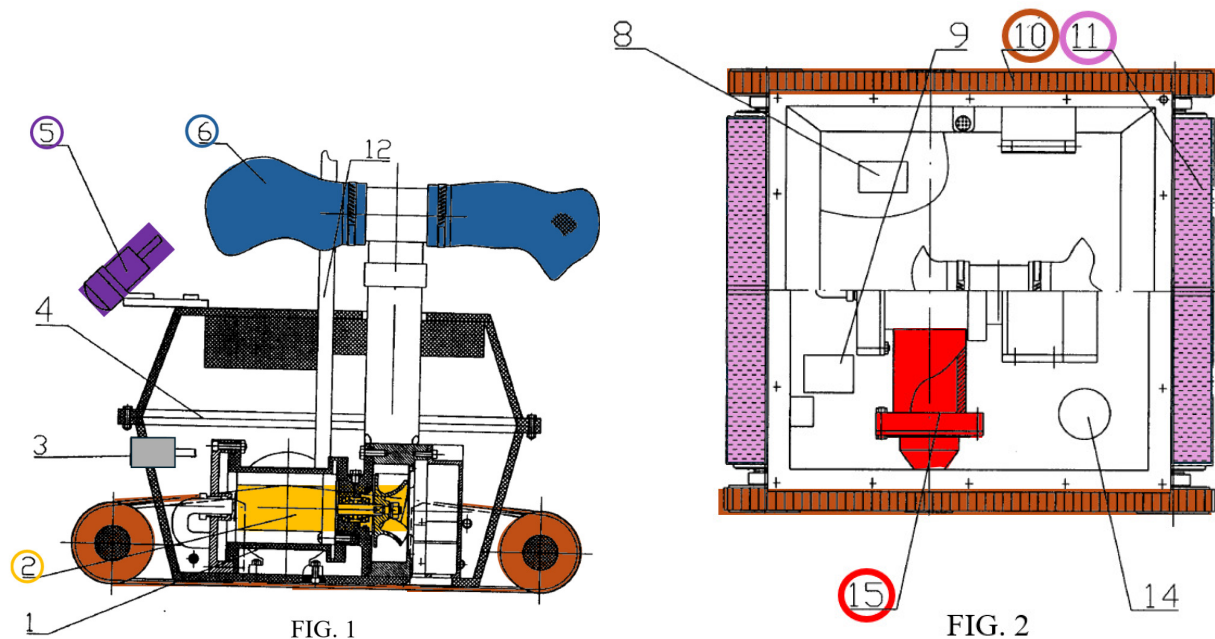
1. Cui

70. Cui (EX1005), an analogous art and in the same field of endeavor as the '207 Patent, discloses a pool cleaner with debris detection capability for use in swimming pools. Cui, Title, Abstract. The pool cleaner uses a CCD camera to continuously capture images of pool surfaces, compare them with pre-stored standard images of clean surfaces, and controls the cleaner's operation based on

detected debris levels/distributions. *Id.*, Abstract, pp.5-7².

71. As illustrated in FIGS. 1-2 (annotated below), Cui's pool cleaner comprises a housing 4 containing various components including a **brushless DC water pump motor 2**, an infrared distance sensor 3, a **CCD camera 5**, a **filter bag 6**, an industrial control computer 7 with related software, sensors 8, 9, a **track-type crawling mechanisms 10**, **roller brushes 11**, and **hybrid stepper motors 15**.

Cui, Claim 1, pp.4-5, FIGS. 1-3.



Cui, FIGS. 1-2 (annotated)

² Page citations to Cui are to the original pagination in the bottom center of each page.

72. As illustrated in FIGS. 5-6, computer 7 is connected to camera 5 through image acquisition card 21 and processes the captured images to generate control signals that adjust the crawling speed based on detected debris levels/distributions. Cui, pp.4-7, FIGS. 5-6. Image acquisition card 21 connects to camera 5; stepper motor control card 18 connects to motors 15. *Id.* Camera 5 captures images that undergo A/D conversion and comparison with standard images stored on computer 7. *Id.* Greater sediment/debris levels produce larger grayscale differences, causing computer 7 to adjust speed of motor 15 via relay board 20, controlling crawling speed and cleaning force. *Id.*

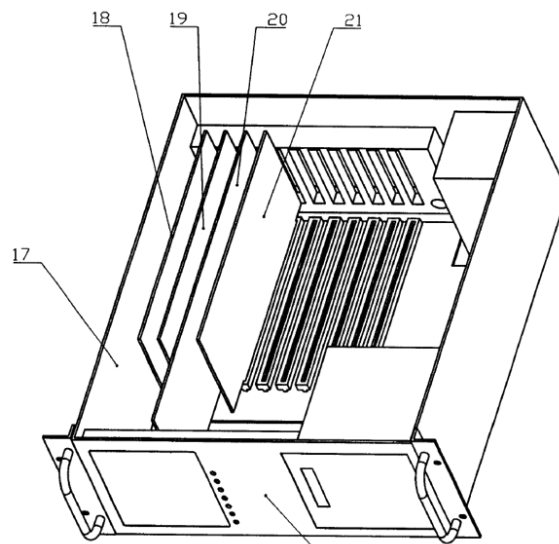


FIG. 5

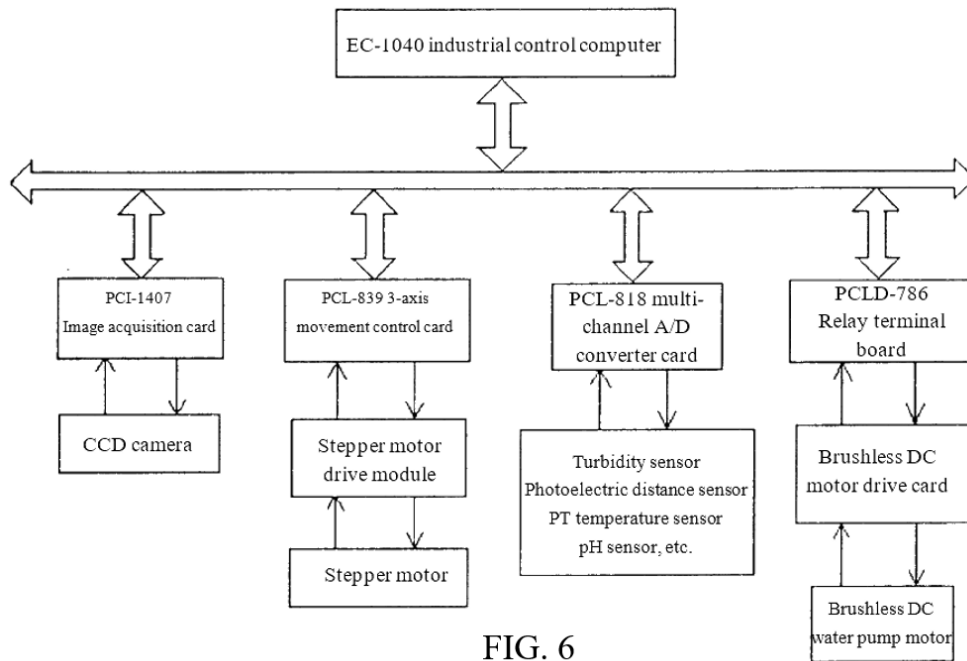


FIG. 6

73. Human-machine interface 16 of computer 7 displays pool area with different colors to indicate cleaned areas and areas to be cleaned, sensor values, and control switches. Cui, p.6, FIG. 4.

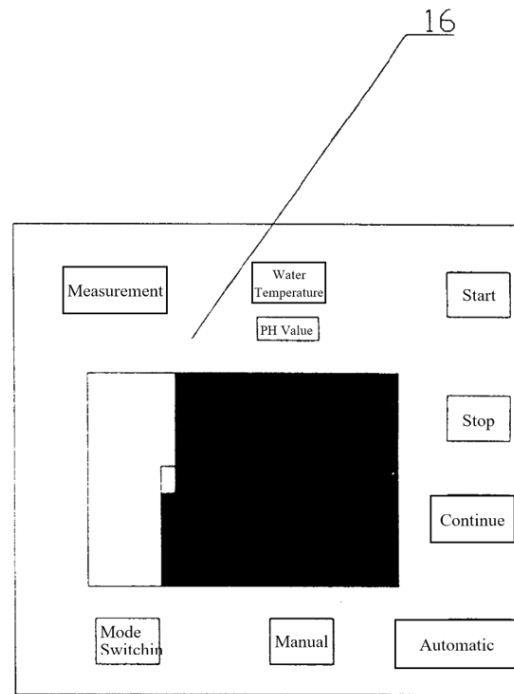


FIG. 4

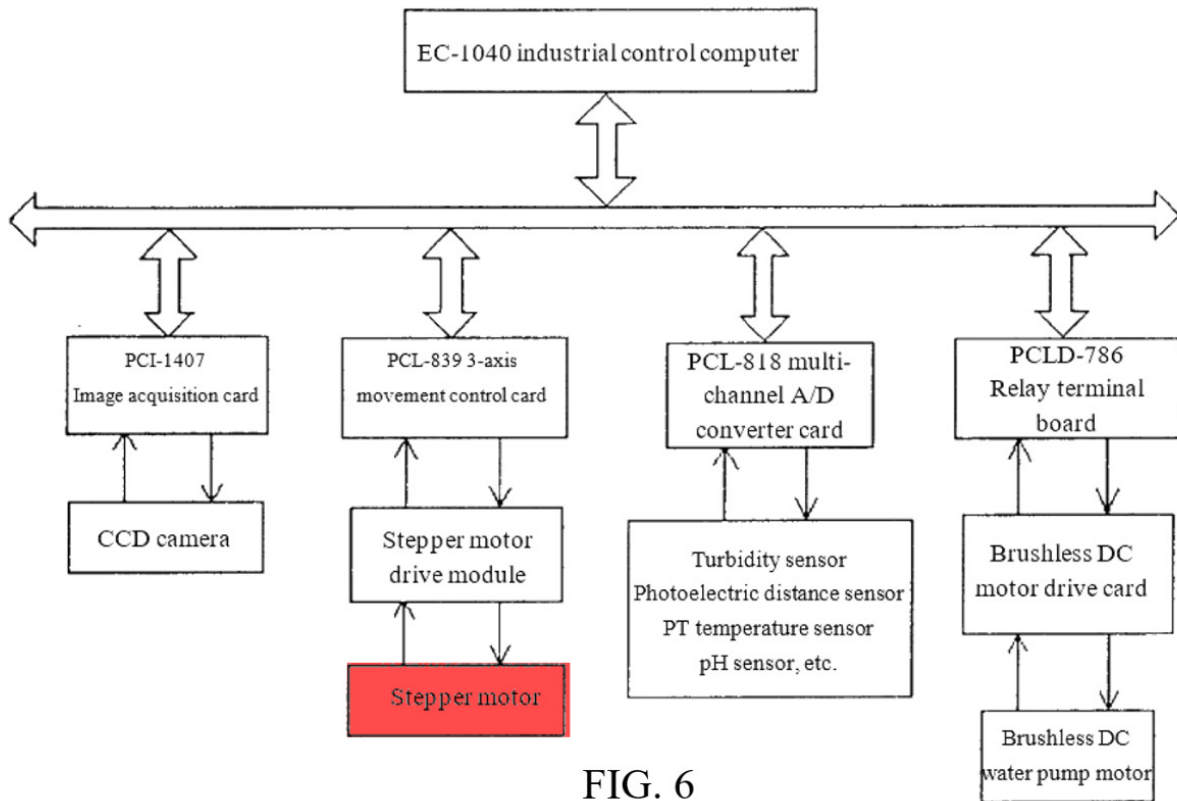
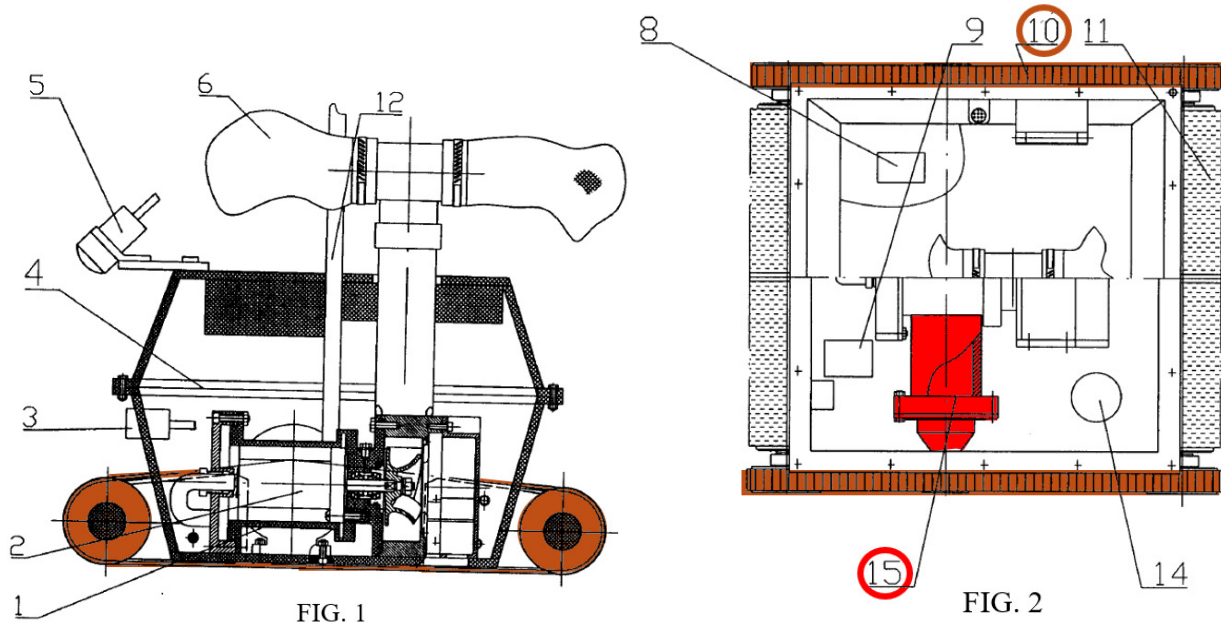
2. Claim 1

74. In my opinion, Cui discloses or suggests Claim 1.

- a. 1[pre] “A self-propelled pool cleaning system for cleaning debris from a submerged surface of a swimming pool, comprising:”

75. In my opinion, Cui discloses or suggests 1[pre].

76. Cui discloses a system designed for “professional or commercial swimming pools,” including an underwater cleaning vehicle with **track-type crawling mechanisms 10** powered by **hybrid stepper motor 15** and a computer 7 that processes sensor data and controls the vehicle. Cui, Abstract, Claim 1, pp.5-7, FIGS. 1-2, 6 (annotated below).



77. Cui's cleaning vehicle is self-propelled because under the control of

computer 7, motors 15 drive track-type crawling mechanisms 10 to move it across pool surfaces. Cui, Claim 1, pp.5-6.

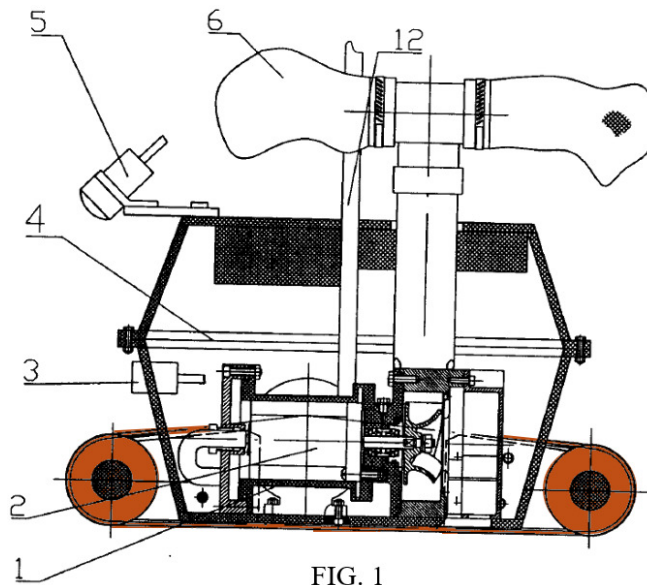
78. Cui's system detects debris by capturing images with camera 5 and comparing them (via computer 7) with "pre-stored standard image information of a clean pool bottom"—"when there is a lot of sediment at the pool bottom, the grayscale level of the real-time captured image(s) is greatly different from the grayscale level of the original standard image(s)." Cui, Abstract, pp.4-7. Cui's system collects and cleans debris using "roller brush (11)," "brushless DC water pump motor (2)," and "filter bag (6)." Cui, Claim 1, pp.5-7.

b. 1[a] "a. a vehicle body"

79. In my opinion, Cui discloses or suggests 1[a].

80. Cui's pool cleaner includes a vehicle body, at least in the form of housing 4 with integrated propulsion mechanisms (track-type crawling mechanisms 10, motors 15), cleaning components (motor 2, brushes 11, filter 6), and sensors (camera 5). Cui, Claim 1, pp.5-6, FIG.1 (annotated below). POSITAs would have understood this assembled structure is the claimed "vehicle body" that travels within the pool. Specifically, POSITAs would have recognized that in the context of mobile robotics, a "vehicle body" constitutes the central chassis or structural frame upon which propulsion and functional payloads are mounted. Here, housing 4 provides

the necessary structural integrity to hold the drive tracks (1) and cleaning pump (2) in a fixed spatial relationship, thereby defining the physical form of the “vehicle” that navigates the pool.



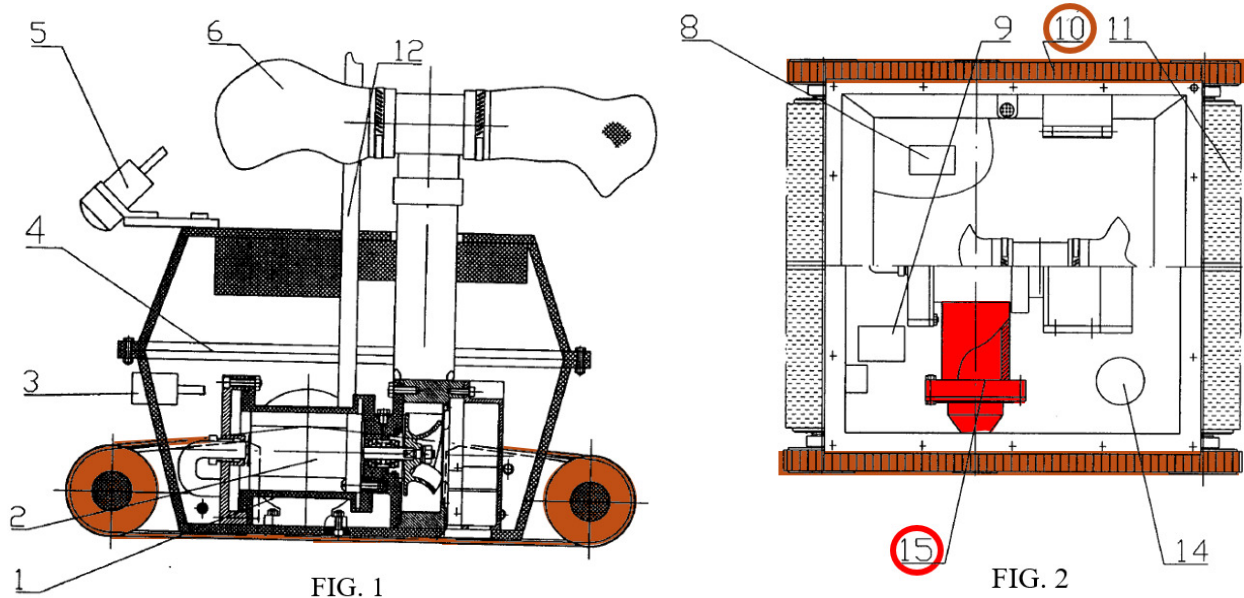
c. 1[b] “b. means for moving the vehicle body within the swimming pool”

81. In my opinion, Cui discloses or suggests 1[b].

82. The format and content of 1[b] invokes 35 U.S.C. §112(f). As explained in §VI.C, the recited function is “moving the vehicle body within the swimming pool,” and the corresponding structures are “wheels, rollers, tracks, other surface contacting members powered by a motor, a vacuum, or a liquid jet.” EX1001, 3:33-45, 10:15-17, FIGS.9-10.

83. Cui discloses moving the vehicle body within the swimming pool. Specifically, Cui discloses **track-type crawling mechanisms 10** powered by

motors 15. Cui, Claim 1, pp.5-6, FIGS. 1-2 (annotated below). Motors 15 are mounted on both sides of sealed motor cover 1, and track-type crawling mechanisms 10 are mounted at front and rear ends of housing 4. *Id.*



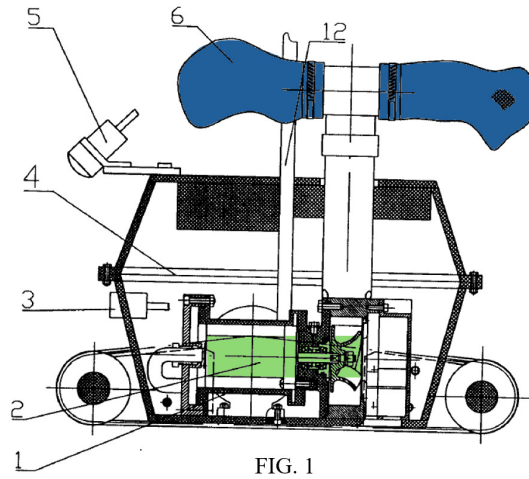
84. A POSITA would have understood that Cui's track-type crawling mechanisms 10 powered by hybrid stepper motors 15 are substantially the same as the '207 Patent's disclosed "tracks...powered by a motor"—both are motor-powered track systems that contact pool surfaces to propel the vehicle body. Specifically, a POSITA would have recognized that Cui's mechanism functions identically to the disclosed structure in the '207 Patent by utilizing an electric motor to drive a continuous, surface-contacting belt (the track) to generate traction against the pool floor. Because Cui employs the exact "tracks" and "motor" components identified as corresponding structure in the '207 Patent, a POSITA would have regarded Cui's

structure as structurally identical to the means claimed. Cui's structure performs the claimed function because motors 15 drive track-type crawling mechanisms 10, which contact pool surfaces and propel the vehicle body within the swimming pool. Cui, pp.5-7, FIGS. 1-3; EX1001, 3:33-45.

d. 1[c] “c. a filter configured to retain debris collected from the submerged surface”

85. In my opinion, Cui discloses or suggests 1[c].

86. Cui's system includes a filter configured to retain debris collected from the submerged surface, at least in the form of **filter bag 6**, which is in the water circulation system including **brushless DC water pump motor 2**. Cui, Claim 1, p.6, FIG.1 (annotated below). A POSITA would have understood that Cui's pump motor 2 draws water containing debris from pool surfaces by suction and filter bag 6 retains this collected debris, while allowing clean water to pass through. A POSITA would have recognized that the specific arrangement of a “filter bag” within the “water circulation” path driven by the pump is the standard mechanism for debris retention in this field. A POSITA would have understood that as the pump generates the necessary suction to lift sediment from the “pool bottom” (the submerged surface), the filter bag functions as a permeable barrier that physically entraps solid particulates while permitting the liquid medium to recirculate, thereby “retaining” the debris as claimed.



- e. 1[d] “d. at least one camera for capturing an image of at least a first object within the swimming pool”

87. In my opinion, Cui discloses or suggests 1[d].

88. Cui’s pool cleaner includes **camera 5** positioned at the upper front end of housing 4 to observe pool surfaces ahead of the cleaner. Cui, Claim 2, FIG.1 (annotated below), pp.5-6.

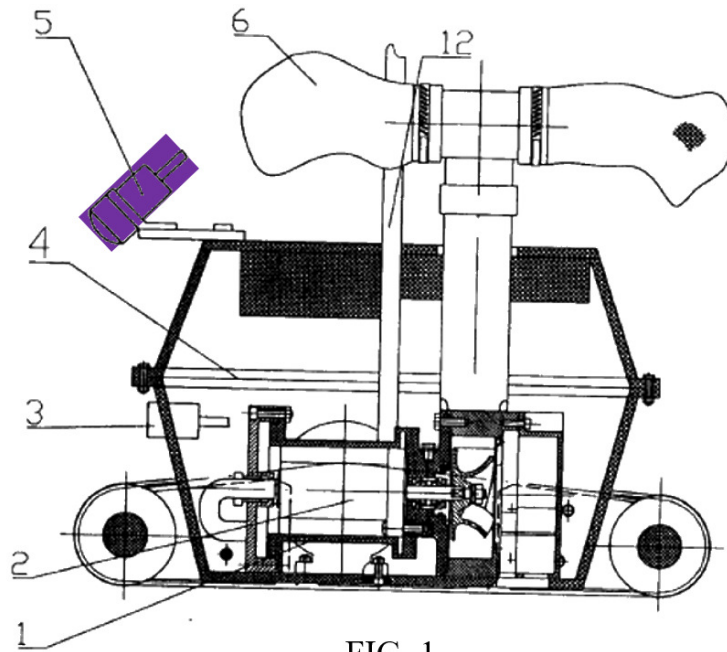


FIG. 1

89. Cui's camera "continuously captures images of areas to be cleaned located directly in front and below a crawling direction of the cleaner," including images showing "sediment at the pool bottom." Cui, pp.6-7.

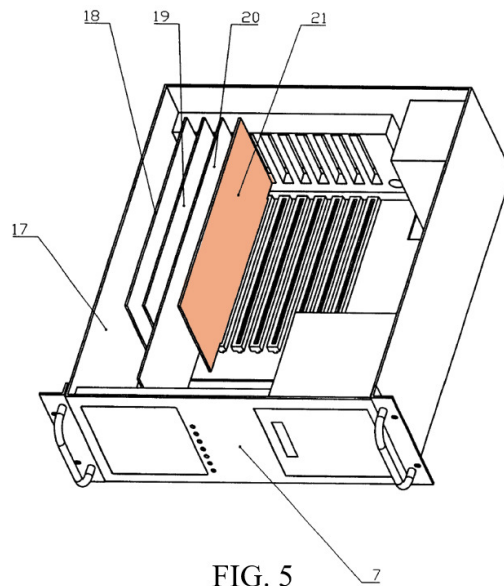
90. A POSITA would have understood that Cui's camera captures images of "at least a first object within the swimming pool" because the camera observes the pool bottom surface and debris/sediment on that surface (both are physical objects within the pool), and these surfaces and debris are within the swimming pool as the cleaner operates while submerged. Furthermore, a POSITA would have recognized that the "sediment" or "debris" detected by Cui constitutes a physical "object" distinct from the water medium. Because Cui describes analyzing the "grayscale level" of these features to distinguish them from a "clean pool bottom,"

the camera necessarily captures an optical representation (an image) of these physical entities. Thus, whether the "first object" is identified as the debris particles themselves or the specific section of the pool floor being inspected, Cui's camera functionality satisfies this limitation.

f. 1[e][i] “e. a controller (i) in electronic communication with the at least one camera and”

91. In my opinion, Cui discloses or suggests 1[e][i].

92. Cui’s FIGS. 5-6 (annotated below) shows computer 7 (controller) connected to **camera 5** through **image acquisition card 21**. Cui, p.6, FIGS. 5-6.



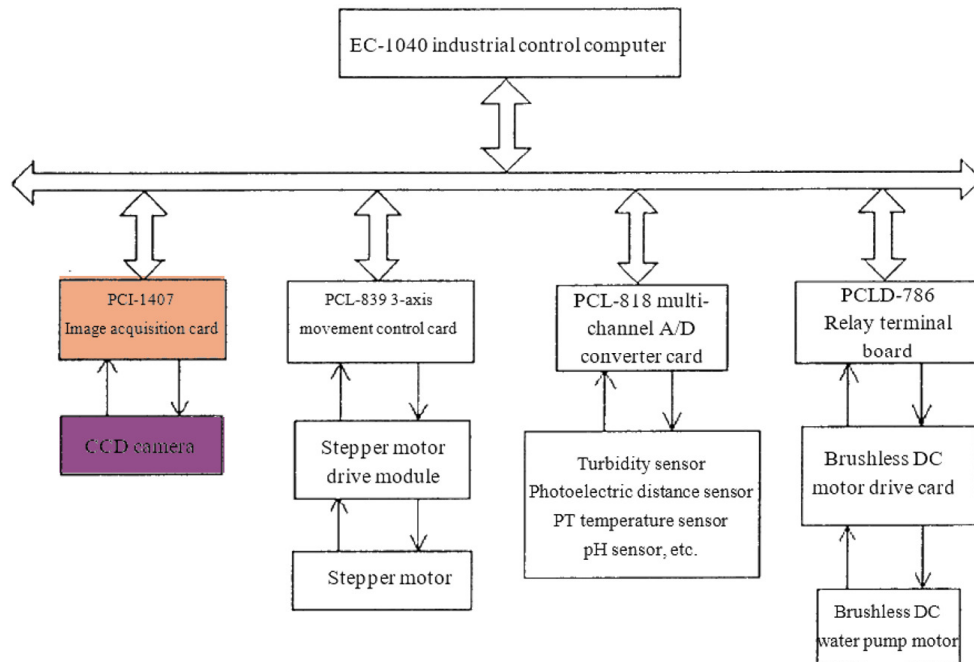


FIG. 6

93. Cui’s camera 5 captures images of pool surfaces and debris. Cui, pp.6-7. Cui’s computer 7 processes these captured images. *Id.* Specifically, Cui describes that during operation, “the video signal undergoes A/D conversion through the high-speed image acquisition card 21 and...is compared with the original standard image(s) of the pool bottom stored in the industrial control computer 7.” *Id.* Computer 7 processes the camera images to determine debris levels and generates control signals for the vehicle’s motors. *Id.* A POSITA would have understood that Cui’s computer 7 is “in electronic communication with” camera 5 because computer 7 receives camera images (via image acquisition card 21) to process them and determine debris levels. A POSITA would have recognized that the transmission of a “video signal” to an “image acquisition card” for “A/D conversion” (analog-to-

digital conversion) constitutes a definitive form of electronic communication involving the transfer of data. Cui, pp.6-7. A POSITA would have understood that for the controller to perform the described comparison between live footage and stored images, there must be an active electronic data pathway transmitting the visual information from the camera sensor to the processor.

- g. 1[e][ii] “(ii) 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.”**

94. In my opinion, Cui discloses or suggests 1[e][ii].

95. As explained in §VII.A.2.f (1[e][i]), Cui’s computer 7 (controller) processes images from camera 5 and generates control signals in response to the captured images. Specifically, Cui describes that computer 7 compares captured images with stored standard images to identify sediment/debris—“when there is a lot of sediment at the pool bottom, the grayscale level of the real-time captured image(s) is greatly different from the grayscale level of the original standard image(s), resulting in a high comparison output voltage.” Cui, pp.6-7. Based on this image-derived voltage signal corresponding to debris levels, “[a] pulse signal command output after processing goes through the relay terminal board 20 to separately control the drive of the two hybrid stepper motors 15.” Cui, pp.6-7. These are “control signal[s]” generated “in response to the captured image.”

96. As explained in §VII.A.2.c (1[b]), motors 15 drive track-type crawling mechanisms 10 that move the vehicle body. The control signals adjust motor speed, thereby controlling movement. Cui, Abstract, pp.6-7.

97. Cui's control signals cause movement "to...the first object." As explained in §VII.A.2.e (1[d]), the "first object" includes debris or an area on a pool surface. Camera 5 captures images "of the areas to be cleaned located directly in front and below the crawling direction of the cleaner." Cui, Abstract, pp.5-7. These are images of debris ahead of the cleaner. *Id.* When the controller generates control signals adjusting movement speed based on detected debris in an area of a pool surface in these forward-looking images, the robot continues moving forward toward the detected debris location—i.e., the control signals cause movement "to" the first object (debris or an area of a pool surface).

98. The claim limitation uses the disjunctive "or" between "to" and "away from," meaning the limitation is satisfied by teaching either alternative. Because Cui teaches at least control signals that cause movement "to" the first object, Cui discloses or suggests this element. A POSITA would have understood or found it obvious that Cui's robotic cleaner travels "to" the debris it detected in order to remove it. Since Cui's camera looks forward and the controller drives the motors to advance the vehicle over the detected debris, a POSITA would have recognized that

these control signals cause movement directed “to” that first object, thereby satisfying this claim limitation.

99. Therefore, in my opinion, Cui renders Claim 1 obvious.

3. Claim 2

100. In my opinion, Cui discloses or suggests Claim 2.

a. 2[pre] “A pool system comprising”

101. In my opinion, Cui discloses or suggests 2[pre].

102. Cui discloses a pool cleaning system designed for “professional or commercial swimming pools” comprising an underwater cleaning vehicle with camera 5, computer 7, sensors, motors, and cleaning mechanisms operating within a swimming pool. Cui, Title, Abstract, Claim 1, pp.5-7, FIGS. 1-6; *see also* §VII.A.2.a (element 1[pre]).

b. 2[a] “at least one piece of equipment for a swimming pool or spa”

103. It is my opinion that Cui discloses or suggests 2[a].

104. Cui discloses a piece of equipment for a swimming pool in the form of the pool cleaner, which is designed for “professional or commercial swimming pools” and includes camera 5, motors, filter bag 6, roller brushes 11, and other cleaning components operating within the swimming pool. Cui, Title, Abstract, Claim 1, pp.5-7, FIGS.1-3; *see also* §VII.A.2.a (element 1[pre]).

c. 2[b] “one or more cameras configured to capture video or images of at least a portion of a location including the swimming pool or spa”

105. It is my opinion that Cui discloses or suggests 2[b].

106. Cui’s pool cleaner includes camera 5, which “continuously captures images of areas to be cleaned located directly in front and below a crawling direction of the cleaner.” Cui, p.5, FIGs.1 (annotated below), 3; *see also* §VII.A.2.e (element 1[d]).

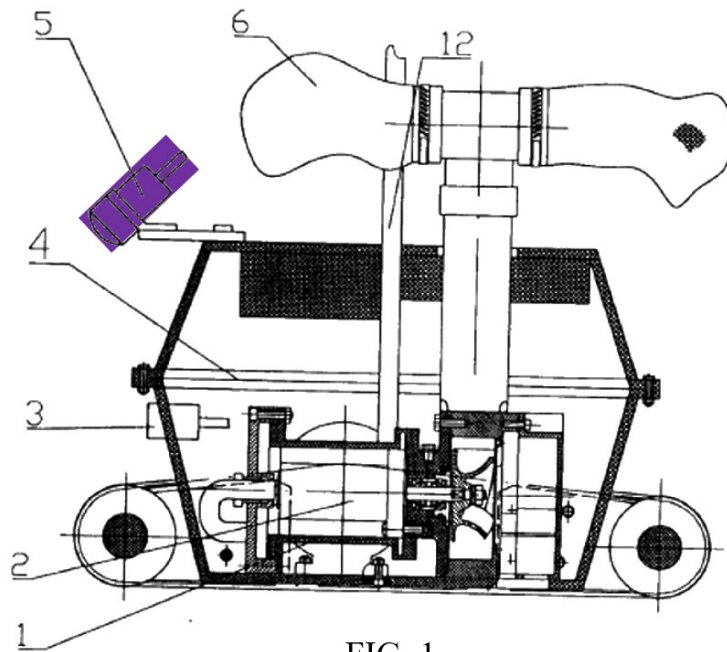


FIG. 1

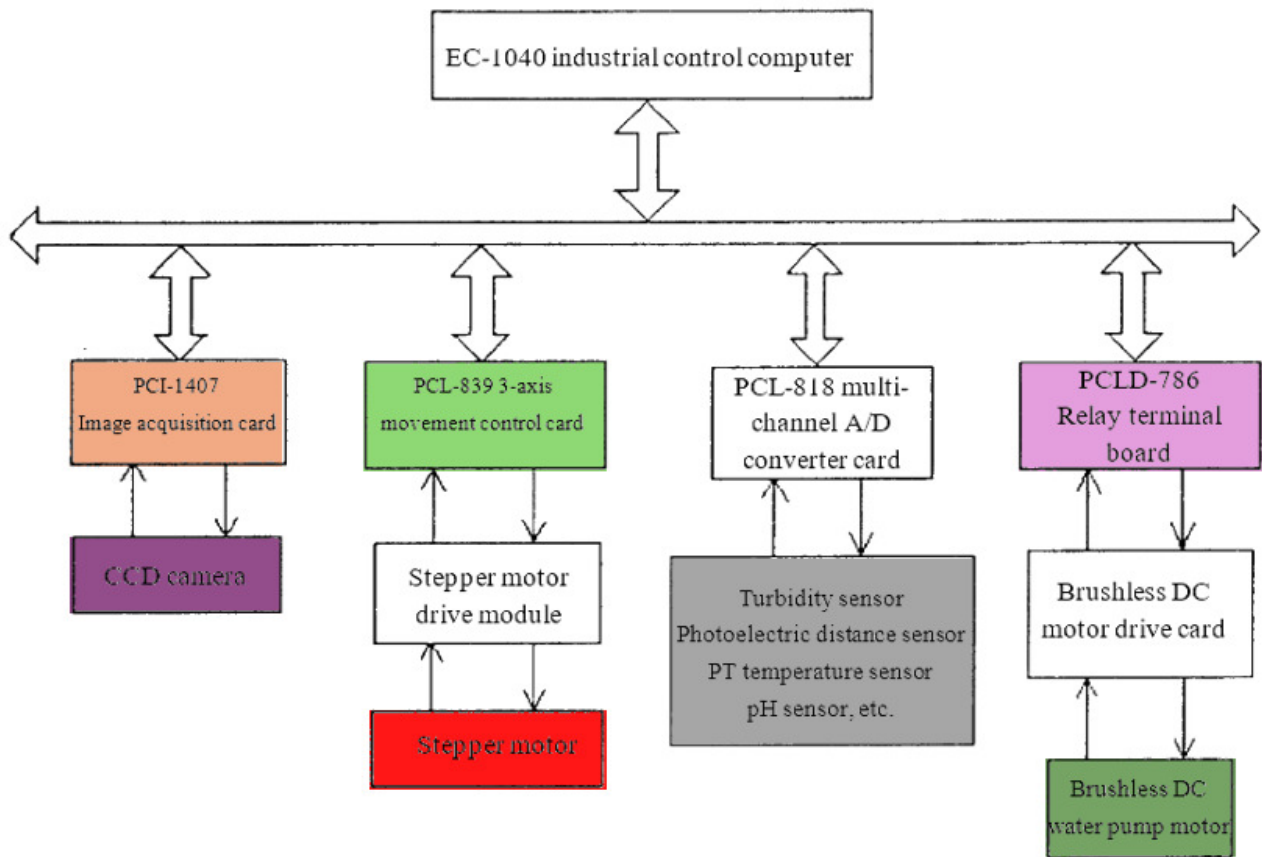
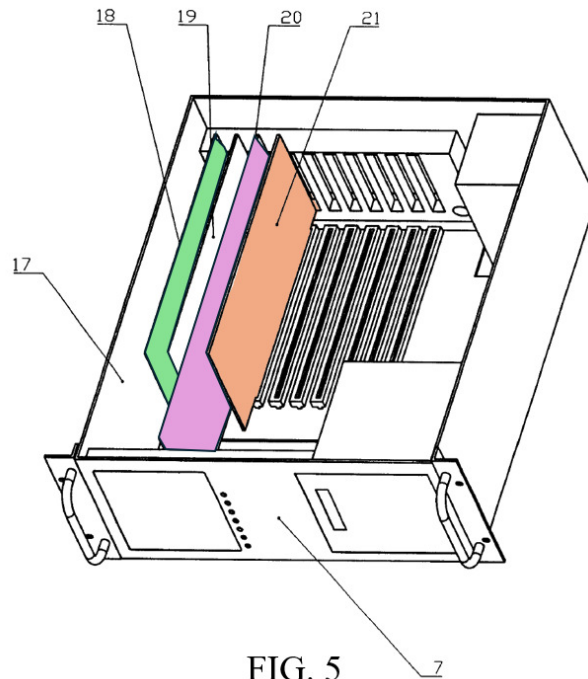
107. A POSITA would have understood that these “areas to be cleaned” on the pool bottom constitute “at least a portion of a location including the swimming pool” because the pool bottom is a physical surface within the “swimming pool.” A POSITA would have recognized that the “pool bottom” is a defining structural

component of the swimming pool's location. Therefore, by capturing images of this surface to detect sediment, Cui's camera is operationally configured to image a specific "portion" of the pool environment, thereby satisfying the limitation.

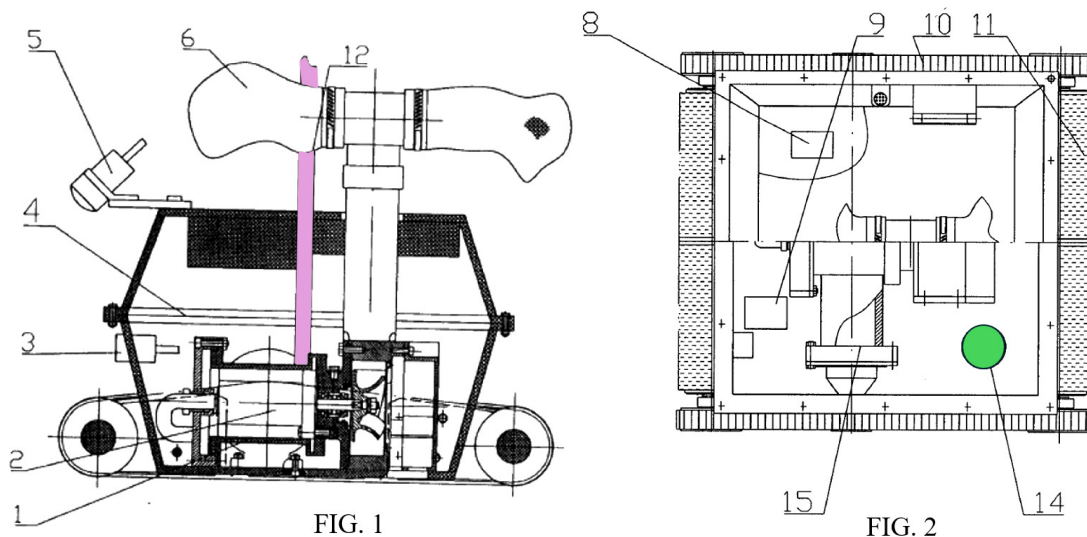
d. 2[c][i] "a controller in communication with the at least one piece of equipment and the one or more cameras,"

108. In my opinion, Cui discloses or suggests 2[c][i].

109. Cui discloses a controller at least in the form of industrial control computer 7. Cui's FIGS. 5-6 (annotated below) shows industrial control computer 7 connected to pool cleaner components, including **CCD camera 5**, **stepper motor 15**, **sensors**, and **brushless DC water pump motor 2**, via interface cards including **image acquisition card 21**, **relay terminal board 20**, and **three-axis stepper motor control card 18**. Cui, pp.5-6, FIGS. 5-6.



110. The industrial control computer 7 is “connected to the pool cleaner through the **cable assembly 12** and the **plug assembly 14**.” Cui, pp.5-6, FIGS. 1-2 (annotated below). Computer 7 is in communication with the pool cleaner (the equipment, as established in §VII.A.3.b element 2[b]) also because computer 7 controls the cleaner’s motors based on processed sensor data— “[a] pulse signal command output after processing goes through the relay terminal board 20 to separately control the drive of the two hybrid stepper motors 15.” Cui, pp.6-7.



111. Computer 7 is in electronic communication with camera 5 because computer 7 receives and processes camera images through image acquisition card 21. Cui, pp.4-7, Claim 3; *see also* §VII.A.2.f (1[e][i]).

- e. **2[c][ii] “the controller configured to receive visual data from the one or more cameras and determine a**

**control action for the at least one piece of equipment
based on the received visual data.”**

112. It is my opinion that Cui discloses or suggests 2[c][ii].

113. Specifically, Cui’s computer 7 (controller) receives images (visual data) from camera 5 through image acquisition card 21. Cui, pp.4-5, FIGS. 5-6; *see also* in §VII.A.2.f (element 1[e][i]), §VII.A.3.d (element 2[c][i]). Then, Cui’s computer 7 processes the images (visual data) to determine debris levels—“when there is a lot of sediment at the pool bottom, the grayscale level of the real-time captured image(s) is greatly different from the grayscale level of the original standard image(s), resulting in a high comparison output voltage.” Cui, pp.6-7; *see also* §VII.A.2.g (element 1[e][ii]).

114. Based on the received visual data, Cui’s controller 7 determines a control action for the pool cleaner (equipment), e.g., an adjustment of the cleaner’s motor/crawling speed. Cui, pp.6-7; *see also* §VII.A.2.g (element 1[e][ii]). A POSITA would have recognized that this mechanism establishes the claimed functional dependency, as the specific magnitude of the motor speed adjustment (the control action) is calculated directly from the grayscale comparison of the captured images (the visual data), thereby ensuring the action is determined based on that data.

115. Therefore, in my opinion, Cui renders Claim 2 obvious.

- 4. Claim 3 (“The pool system of claim 2, wherein the at least one piece of equipment comprises a cleaning device with one or more propulsion mechanisms, the cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation.”)**

116. Claim 3 depends from Claim 2. It is my opinion that Cui discloses or suggests Claim 3.

117. Cui’s pool cleaner (equipment) is a cleaning device with track-type crawling mechanisms 10 and hybrid stepper motors 15 (propulsion mechanisms) that include roller brushes 11, water pump motor 2, and filter bag 6 for cleaning operations. Cui, Title, Claim 1, pp.4, 6; *see also* §VII.A.3.b (2[a]).

118. A POSITA would have understood that Cui’s pool cleaner is “configured to travel adjacent to submerged or water-containing surfaces and to perform a cleaning operation” because it travels on pool bottoms and walls, and removes debris from pool surfaces as it travels, and these surfaces are submerged when the pool is filled with water. *See* §VII.A.2.a (1[pre]), §VII.A.3.b (2[a]). A POSITA would have recognized that for the roller brushes and suction intake to effectively remove debris as disclosed, the vehicle body remains in close proximity (adjacent) to the pool floor or walls throughout its traversal.

119. Therefore, in my opinion, Cui renders Claim 3 obvious.

5. Claim 5 (“The pool system of claim 2, wherein the one or more cameras are mounted on the at least one piece of equipment.”)

120. Claim 5 depends from Claim 2. In my opinion, Cui discloses or suggests Claim 5.

121. Cui describes that its **camera 5** is “mounted at the upper front end of the housing 4” of the cleaner (equipment). Cui, pp.5-6, FIG.1 (annotated below).

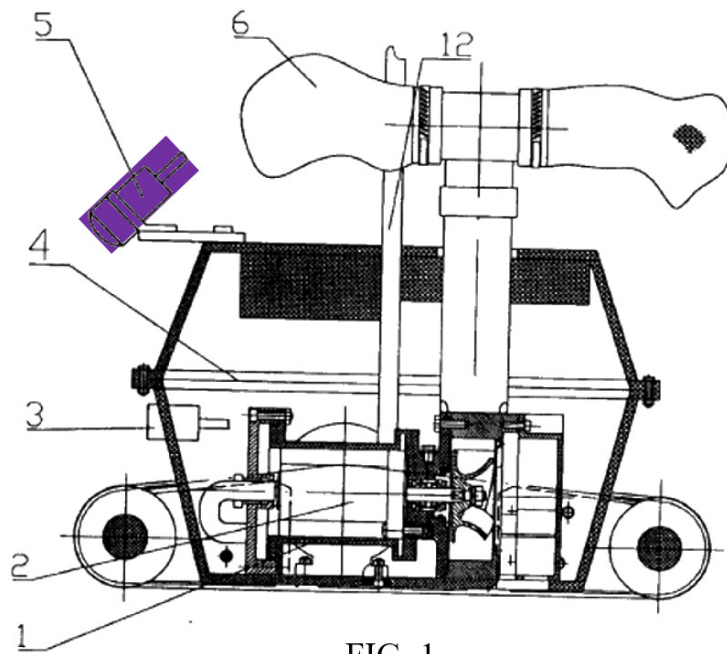


FIG. 1

122. Because camera 5 is mounted on housing 4, which is part of the pool cleaner, camera 5 is mounted on the equipment as claimed. Cui, pp.5-6, Claim 1, FIG.1.

123. Therefore, in my opinion, Cui renders Claim 5 obvious.

6. Claim 6 (“The pool system of claim 2, wherein the one or more cameras are submergible or submerged within the swimming pool or spa.”)

124. Claim 6 depends from Claim 2. In my opinion, Cui discloses or suggests Claim 6.

125. Cui’s pool cleaner operates within filled pools to clean pool surfaces. Cui, Claim 1, p.7; *see also* §VII.A.2.a (1[pre]). Cui’s camera 5 is mounted on the pool cleaner. Cui, pp.5-6; FIG.1; *see also* §VII.A.5 (Claim 5). Hence, a POSITA would have understood that camera 5 is “submergible or submerged within the swimming pool” because it is mounted on the pool cleaner that operates submerged within the swimming pool. A POSITA would have understood that because the camera is an integral sensor fixed to the chassis of a robot designed for underwater operation, it is configured to be “submerged” during use.

126. Therefore, in my opinion, Cui renders Claim 6 obvious.

7. Claim 7 (“The pool system of claim 2, wherein the controller is configured to detect a characteristic of the location based on the visual data and control the piece of equipment based on the detected characteristic.”)

127. Claim 7 depends from Claim 2. In my opinion, Cui discloses or suggests Claim 7.

128. Cui’s computer 7 (controller) processes images to detect debris level/distribution on the pool area to be cleaned, and control the cleaner (equipment),

e.g., its moving speed, based on detected debris level/distribution. Cui, pp.5-7, FIGS. 5-6; *see also* §VII.A.3.e (2[c][ii]). A POSITA would have understood this debris level/distribution is a “characteristic of the location” because it describes the physical state—i.e., the cleanliness—of that pool area. A POSITA would have appreciated that in the field of automated cleaning, a “characteristic” of interest would include its state of cleanliness. Consequently, by quantifying the “distribution of debris” or “sediment” level at a specific spot on the pool bottom, Cui’s system is detecting a physical attribute—or characteristic—of that location to determine the appropriate cleaning response.

129. Therefore, in my opinion, Cui renders Claim 7 obvious.

8. Claim 8

130. Claim 8 depends from Claim 7, which depends from Claim 2. In my opinion, Cui discloses or suggests Claim 8.

a. 8[a] “The pool system of claim 7, wherein the characteristic comprises a cleanliness of a surface of the swimming pool, and”

131. Cui discloses or suggests 8[a]. Cui’s computer 7 (controller) detects debris level/distribution (characteristic) on pool surfaces by comparing captured images with stored “clean surface” standard images. Cui, pp.5-7; *see also* §VII.A.7 (Claim 7). A POSITA would have understood that debris levels indicate pool surface

cleanliness—heavy debris indicates less clean surfaces, and minimal debris indicates cleaner surfaces. A POSITA would have recognized that by measuring the “varying distribution of debris” or sediment load via image analysis, Cui’s system assesses the cleanliness metric of the surface—where a high deviation from the “clean” standard image corresponds to low cleanliness, and a low deviation corresponds to high cleanliness.

b. 8[b] “wherein the controller is configured to control the piece of equipment based on the detected cleanliness being outside of a threshold.”

132. In my opinion, Cui discloses or suggests 8[b].

133. Cui’s computer 7 (controller) compares captured images with stored “clean surface” images and adjusts motor speeds when detected cleanliness differs from that standard—“when there is a lot of sediment at the pool bottom, the grayscale level of the real-time captured image(s) **is greatly different** from the grayscale level of the original **standard image(s)**, resulting in a high comparison output voltage” that controls motor speeds. Cui, pp.5-7; *see also* §VII.A.3.e (2[c][ii]). A POSITA would have understood that Cui’s “pre-stored standard image information of a clean pool bottom” constitutes a “cleanliness threshold,” because it represents the baseline of “cleanliness” against which the current state is measured. Cui, pp.5-7. A POSITA would have recognized that a “threshold” in image

processing and control systems acts as a reference value determining a change in state. By storing an image of a clean bottom and comparing real-time footage against it, Cui's system sets the grayscale values of the clean image as the "threshold." Any significant deviation from these stored values—representing the presence of debris—crosses this limit, thereby identifying the state as "unclean" and triggering the control response.

134. Furthermore, a POSITA would have understood that Cui's system determines the cleanliness is "outside of a threshold" when the real-time image deviates from this standard image (i.e., is "greatly different"). Even if Cui employs a continuous feedback loop (where voltage varies with the amount of sediment), its control action (adjusting motor speed) is triggered specifically because the detected cleanliness level has deviated from (i.e., is outside) the standard defined by the stored image. A POSITA would have recognized or found it obvious that the "threshold" in such a control loop defines the boundary of the reference state (the clean standard)—when the cleanliness matches this standard (within operational tolerances), it is "inside" the threshold (resulting in nominal or zero error voltage), and when it deviates, it is "outside" the threshold, generating the "high comparison output voltage." Accordingly, Cui's system controls the equipment based on the deviation from the standard (the threshold), satisfying the limitation regardless of whether the

resulting speed adjustment is binary or proportional.

135. Therefore, in my opinion, Cui renders Claim 8 obvious.

9. Claim 12

136. It is my opinion that Cui discloses or suggests Claim 12.

a. 12[pre] “A method for monitoring a pool system, the method comprising”

137. In my opinion, Cui discloses or suggests 12[pre].

138. Cui discloses “a pool system” including a pool cleaner and an industrial control computer 7. Cui, pp.5-7, FIGS. 5-6; *see also* §VII.A.3.a (2[a]). A POSITA would have understood that Cui’s method, including, among others, capturing images, detecting debris based on the images, and controlling cleaner movements based on detected debris constitutes “monitoring a pool system.” *Id.*

b. 12[a] “receiving images of at least a portion of a location including a swimming pool or spa from one or more cameras;”

139. In my opinion, Cui discloses or suggests 12[a].

140. Cui discloses that camera 5 captures images of pool surfaces ahead of the cleaner, and computer 7 receives the video signals (comprising multiple images captured over time) from camera 5 through image acquisition card 21 for processing. Cui, Abstract, Claim 3, pp.5-7; *see also* §§VII.A.3.c-VII.A.3.d (2[b]-[c][i]).

c. 12[b] “determining a target area and detecting a characteristic of the target area based on the images; and”

141. In my opinion, Cui discloses or suggests 12[b].

142. Cui’s method involves its computer 7 (controller) receiving images from camera 5 and, detecting debris level (characteristic) of an area based on the images, and based on this detected characteristic, the controller adjusts the cleaner’s crawling speed in that specific area. Cui, pp.4-7, FIGS. 5-6; *see also* §§VII.A.2.e-VII.A.2.g (1[d]-1[e][ii]) and §§VII.A.7-VII.A.8 (Claims 7-8). Because the Cui system’s control action (adjusting the speed) is applied to a specific area in response to the debris detected in that same area, a POSITA would have understood or found it obvious that Cui’s system determines the area, from which the images are captured, and in which the movement control will be applied, to be a target area (e.g., a target area for application of updated movement controls). A POSITA would have recognized that the field of view of the image currently being processed functionally defines the “target area.” Since Cui’s system captures images of the “areas to be cleaned” to make real-time decisions, the system isolates and determines this specific region as a target area for both characteristic detection (e.g., debris analysis) and the subsequent control action (e.g., speed adjustment).

d. 12[c] “generating a control response based on the detected characteristic of the target area.”

143. It is my opinion that Cui discloses or suggests 12[c].

144. Cui's computer 7 assesses debris levels and generates pulse signal commands that control motor speeds to adjust cleaning force—"a corresponding cleaning force can be selected according to a varying distribution of debris on the pool bottom." Cui, Abstract, p.5; *see also* §§VII.A.3.e&VII.A.7 (2[c][ii], Claim 7).

145. A POSITA would have understood that Cui's pulse signal commands constitute "a control response" generated "based on the detected characteristic" (debris level or cleanliness) of the target area (pool surface). A POSITA would have recognized that the generation of this specific pulse signal is causally linked to the condition of the target area; had the detected debris distribution been different (e.g., cleaner), the computer would have generated a different pulse signal (or none at all), thereby confirming that the control response is determined by, and thus "based on," the characteristic of that specific target area.

146. Therefore, in my opinion, Cui renders Claim 12 obvious.

10. Claim 13

147. Claim 13 depends from Claim 12. In my opinion, Cui discloses or suggests Claim 13.

a) 13[a] "The method of claim 12, wherein the target area comprises a portion of a surface of the swimming pool or spa, and"

148. It is my opinion that Cui discloses or suggests 13[a].

149. Cui's target area is the specific area of the pool surface which computer 7 determines contains debris. Cui, pp.6-7; *see also* §VII.A.9.b-VII.A.9.d (12[b]-[c]).

a. 13[b] “wherein the characteristic comprises a cleanliness characteristic of the portion of the surface of the swimming pool or spa.”

150. It is my opinion that Cui discloses or suggests 13[b].

151. Cui's computer 7 detects debris level (cleanliness characteristic) of the target area, which is a portion of the pool surface. Cui, pp.5-7; *see also* §§VII.A.7-VII.A.8.a (Claim 7, 8[a]).

152. Therefore, in my opinion, Cui renders Claim 13 obvious.

11. Claim 14

153. Claim 14 depends from Claim 12. It is my opinion that Cui discloses or suggests Claim 14 because Cui's computer 7 generates pulse signal commands (control response) that control movement (operation) of a pool cleaner (equipment of the swimming pool). Cui, pp.5-7; §VII.A.9.d (12[c]) and §VII.A.3.b (2[a]).

154. Therefore, in my opinion, Cui renders Claim 14 obvious.

12. Claim 19

155. Claim 19 depends from claim 12. In my opinion, Cui discloses or suggests Claim 19.

a) 19[a] **“The method of claim 12, wherein generating the control response comprises controlling operation of a cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation,”**

156. Cui discloses or suggests 19[a] because Cui’s system generates pulse signal commands (control response) that controls motors and movement (operation) of the pool cleaner (equipment). Cui, pp.6-7; *see also* §§VII.A.9.d (12[c]), VII.A.11 (Claim 14). Cui’s pool cleaner is configured to travel adjacent to a bottom of (submerged or water-containing surfaces) of the swimming pool and performs a cleaning operation. Cui, pp.5-7; *see also* §§VII.A.2.a (1[pre]), VII.A.4 (Claim 3), VII.A.6 (Claim 6).

a. 19[b] **“wherein controlling operation of the cleaning device comprises one or more of controlling a path or route of the cleaning device, an aggressiveness of cleaning chemicals deployed, an aggressiveness of mechanical cleaning, or a speed of the cleaning device.”**

157. In my opinion, Cui discloses or suggests 19[b].

158. Cui’s system generates pulse signal commands (control responses) that control rotational speed of hybrid stepper motors 15, which a POSITA would have understood controls “the crawling speed of the cleaner” (speed of the cleaning device). Cui, p.7; *see also* §VII.A.9.d (12[c]). Cui teaches that “the crawling speed of the cleaner indirectly reflects the magnitude of the cleaning force.” Cui, pp.6-7,

FIG.7. Although stated in the context of Cui's turbidity-based embodiment, Cui further explains the relationship: when "the crawling speed of the cleaner slows down...the cleaning force increases." Cui, Abstract, p. 9, FIG.7. A POSITA would have understood this relationship between crawling speed and cleaning force to apply equally to Cui's image-based debris detection embodiment, as both embodiments use the same mechanical cleaning components (roller brushes 11, track-type crawling mechanisms 10) and both aim to achieve "different cleaning forces" corresponding to "different distributions of debris." Cui, Abstract, pp.4-5, 7.

159. Additionally, Cui describes directional control enabling the cleaner to "move forward, backward, or turn left and right" and execute "180° turns" near pool walls "until the entire pool is cleaned," which constitutes controlling the cleaner's path. Cui, p.7.

160. Therefore, it is my opinion that Cui renders Claim 19 obvious.

B. Ground 1B: Claims 8 and 16 are Unpatentable over Cui and Fu-007

1. Fu-007

161. Fu-007 (EX1007), which is analogous art and in the same field as the '207 Patent, discloses an underwater cleaning robot for swimming pools that operates in remote control and autonomous modes. Fu-007, Title, Abstract.

162. Fu-007's system includes **monitoring camera 2**, image acquisition

card, central processing unit (controller) housed in **control system enclosure 8**, and cleaning and moving platform with independently controllable **cleaning drive wheels 3** and drainage devices. Fu-007, pp.12-14,³ Claims 1, 3, FIGS. 1-3 (annotated below).

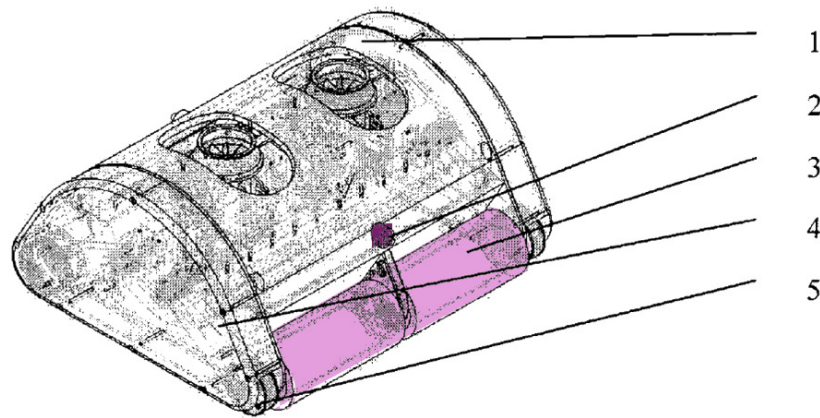


FIG. 1

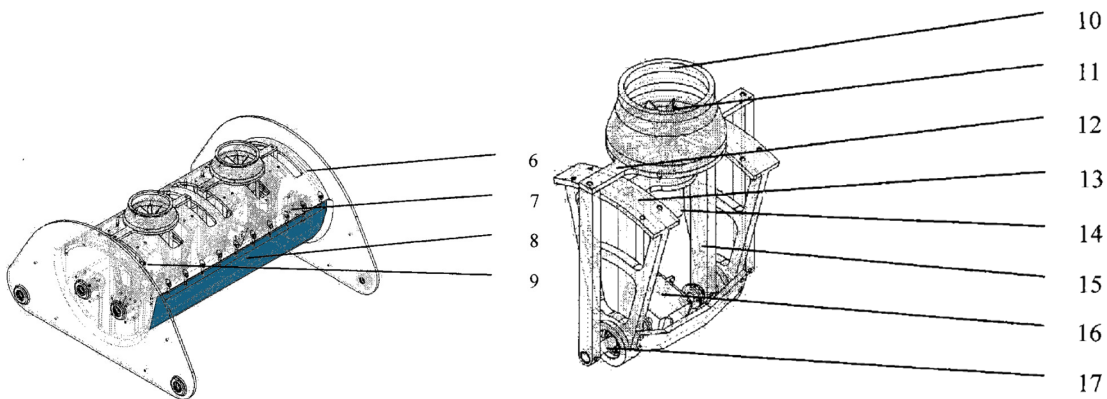


FIG. 2

FIG. 3

³ Page citations to Fu-007 are to the original pagination in the bottom center of each page.

163. During autonomous cleaning, Fu-007 implements threshold-based cleanliness control by setting “a swimming pool cleanliness image threshold,” with the central processing unit receiving images captured by camera 2, comparing the images with the threshold to determine cleanliness level, and adjusting operating conditions of the cleaning drive wheels and drainage device accordingly. Fu-007, pp.14-16, Claims 4, 7.

164. Fu-007’s robot includes wireless communication capability through a control signal buoyant antenna 27 that “floats on a water surface to wirelessly communicate with the control keyboard 31” and “is connected to the robot via the control signal buoyant antenna cable (35).” Fu-007, pp.8-10, 12-16, Claims 4-5, 7, FIG. 8 (annotated below). Fu-007 teaches controlling the robot “with the cable” for “long-term global cleaning” and using the “control signal buoyant antenna 27” to “wirelessly communicate” for “short-term local cleaning.” Fu-007, pp.9-10, 14, Claim 5.

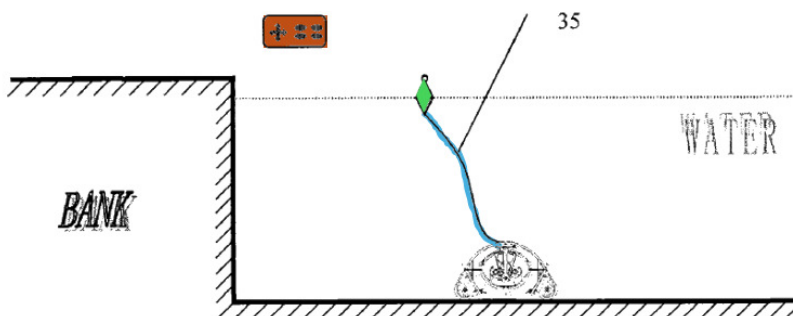


FIG. 8

2. Reasons for Combining Cui and Fu-007

165. Both Cui and Fu-007 disclose underwater cleaning robots for swimming pools using camera-based control, and both sought to improve autonomous pool cleaning operations. Cui describes a pool cleaner using “intelligent adaptive technology with computer control” to autonomously adjust cleaning force based on debris distribution. Cui, pp.5-7. Fu-007 similarly describes an underwater cleaning robot that can “help and even replace humans to autonomously complete underwater cleaning work.” Fu-007, p.11. A POSITA would have been motivated to combine their complementary teachings of Cui and Fu-007 to achieve improved autonomous pool cleaning systems.

166. A POSITA would have recognized that the teachings in Cui and Fu-007 are directed to the same pool cleaning technical field, are based on recognition of the same or similar technical issues in pool cleaning, and provide similar technical solutions to address similar technical issues.

167. Specifically, both references use a camera and controller to process captured images and generate control signals to cause movement of the pool cleaning robot. Cui discloses CCD camera 5 that captures images “of the areas to be cleaned,” industrial control computer 7 that compares captured images to stored “clean surface” standard images to detect debris, and generates control signals to adjust the

“crawling speed of the cleaning machine body” based on debris distribution. Cui, pp.5-7, FIGS. 1-3, 5-7. Fu-007 similarly discloses monitoring camera 2 that captures images of pool surfaces, a central processing unit that compares “the image(s) with the threshold” to determine “a cleanliness level of the bottom of the swimming pool,” and generates control signals to adjust “operating conditions of the four cleaning drive wheels 3 and the drainage device to complete the cleaning task.” Fu-007, pp.8-10, 12-16, Claims 1-4, 7, FIGS. 1, 6.

168. Additionally, both references teach motorized drive mechanisms to cause and control movement of the pool cleaner during operation. Cui discloses a “driving motor” that propels the cleaner body along pool surfaces, with crawling speed adjusted based on detected debris levels. Cui, pp.5-7, Claim 1, FIGS. 1-3. Fu-007 similarly discloses “four independently driven” “cleaning drive wheels 3” where “the rotational speed of each wheel 3 is adjustable” and “[t]hrough different wheel speed combinations, cleaning actions with different cleaning intensities can be implemented.” Fu-007, pp.8-10, 12-16, Claims 1, 3, 7. Accordingly, a POSITA would have investigated the technical teachings in both Cui and Fu-007 to seek guidance when designing a pool cleaning system for specific pool cleaning considerations and applications.

169. Cui teaches an image comparison approach that compares captured

images with stored “clean surface” standard images to produce a comparison output voltage (Cui, pp.5-7), and Fu-007 employs an explicit threshold-based approach that sets “a swimming pool cleanliness image threshold” and “plans a cleaning movement” based on the comparison. Fu-007, pp.10, 14-16, Claim 7. Additionally, Cui teaches wired communication via cable assembly 12 (Cui, pp.5-6, FIGS. 1-3), and Fu-007 discloses both wired and wireless communication modes, including a control signal buoyant antenna 27 “to wirelessly communicate with the control keyboard 31.” Fu-007, pp.8-10, 12-16, Claims 4-5, 7, FIG. 8. These represent known design alternatives in autonomous pool cleaning systems.

170. A POSITA would have been motivated to modify Cui by selectively incorporating Fu-007’s teachings to advance Cui’s stated goals of “intelligent adaptive technology,” “high reliability,” and “strong applicability.” Cui, Abstract, p.5. Specifically, Fu-007’s explicit threshold-based cleanliness control would have enhanced Cui’s “intelligent adaptive technology” by providing a systematic method for determining cleanliness levels. Fu-007’s wireless communication capability would have improved Cui’s “strong applicability” by enabling operation without physical cable constraints during short-term cleaning operations.

171. A POSITA would have had a reasonable expectation of success in making these modifications because both references employ similar camera-based

systems in the same pool operational environment (underwater pool cleaning), and combining Fu-007's teachings with Cui would have involved routine software and hardware modifications to Cui's existing system, yielding predictable results. Cui, pp.5-7; Fu-007, pp.10, 12-16.

3. Claim 8

172. Claim 8 depends from Claim 7, which depends from Claim 2. In my opinion, the Cui-Fu-007 combination discloses or suggests Claim 8.

a. 8[a] "The pool system of claim 7, wherein the characteristic comprises a cleanliness of a surface of the swimming pool, and"

173. It is my opinion that Cui discloses or suggests 8[a]. *See* §VII.A.8.a (8[a]).

b. 8[b] "wherein the controller is configured to control the piece of equipment based on the detected cleanliness being outside of a threshold."

174. To the extent that this element is found not to be taught or suggested by Cui, in my opinion, it is disclosed or suggested by the Cui-Fu-007 combination.

175. As explained in §§VII.A.7 (Claim 7) and VII.A.8.b (8[b]), Cui already discloses that its computer 7 (controller) controls the cleaner (equipment) based on the detected debris level (cleanliness).

176. As explained in §VII.B.1 (Fu-007 summary), Fu-007 teaches threshold-based cleanliness control by setting "a swimming pool cleanliness image threshold,"

determining “a cleanliness level of the bottom of the swimming pool by comparing the image(s) with the threshold,” and adjusting “operating conditions of the four cleaning drive wheels...to complete the cleaning task” based on the comparison. Fu-007, pp.10, 14-16, Claim 7.

177. As explained in §VII.B.2, a POSITA would have been motivated to incorporate the threshold-setting control logic taught by Fu-007 into Cui’s system with a reasonable expectation of success. In the modified Cui system would set “a swimming pool cleanliness image threshold,” “determine a cleanliness level” from the images from Cui’s camera, and compare this “cleanliness level” to the “threshold” to “plan[] a cleaning movement.” Fu-007, pp. 10, 14-16.

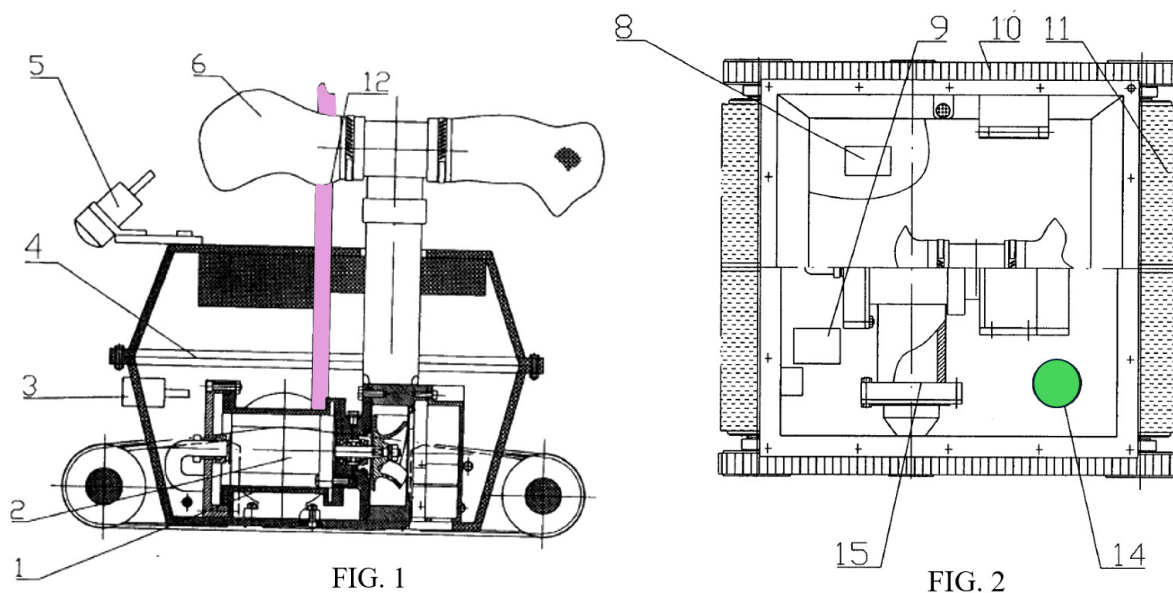
178. In addition to the reasons explained in §VII.B.2, a POSITA would have recognized that Fu-007’s approach enables the controller to “determine[] a cleanliness level” and “autonomously plan[]” a “path and an action.” Fu-007, pp.10, 14-16. A POSITA would have understood this as an enhancement to move beyond Cui’s control (slowing down for debris) and implement more energy-saving cleaning plans (e.g., cleaning only the areas “outside” the “threshold”), resulting in a more efficient and reliable autonomous cleaner.

179. Therefore, it is my opinion that Cui and Fu-007 render Claim 8 obvious.

4. Claim 16

180. Claim 16 depends from Claim 12. In my opinion, the Cui-Fu-007 combination discloses or suggests Claim 16.

181. Cui's computer 7 is remote from the pool cleaner, connected via **cable assembly 12** and **plug assembly 14**. Cui, p.6, FIGS. 1-2 (annotated below); *see also* §VII.A.3.d (2[c][i]), §VII.A.1 (Cui summary).



182. Fu-007 discloses a pool cleaning robot including wireless communication capability through a control signal buoyant **antenna 27** that “floats on a water surface to wirelessly communicate with the **control keyboard 31**” and “is connected to the robot via the control **signal buoyant antenna cable (35)**.” Fu-007, pp.8-10, 12-16, Claims 4-5, 7, FIG. 8 (annotated below). *See also* §VII.B.1 (Fu-007 summary).

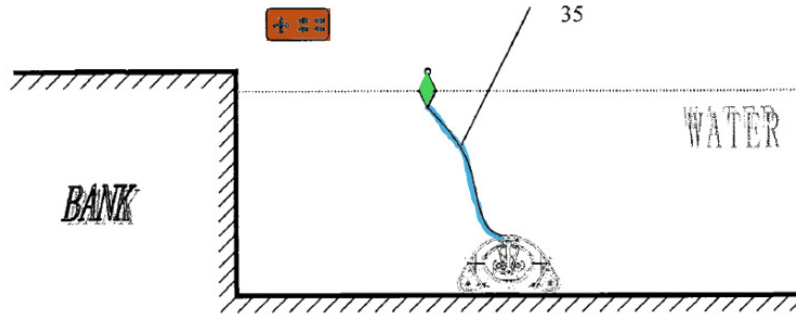


FIG. 8

183. Fu-007 teaches controlling the robot “with the cable” for “long-term global cleaning” and using the “control signal buoyant antenna 27” to “wirelessly communicate” for “short-term local cleaning.” Fu-007, pp.12.

184. As explained in §VII.B.2, a POSITA would have been motivated to combine the teachings of Cui and Fu-007 with a reasonable expectation of success. In the modified system, Cui’s computer 7 (controller) would have a dual-mode (wired and wireless) communication capability, allowing it to generate a “control response” and communicate it either via the existing cable assembly 12 or wirelessly via Fu-007’s buoyant antenna 27 to a remote device (e.g., control keyboard 31).

185. In addition to the reasons explained in §VII.B.2, a POSITA would have been motivated to make this modification because adding Fu-007’s wireless communication as an alternative to Cui’s wired connection would have improved Cui’s stated goal of “high reliability” (Cui, Abstract, p.5) by providing an alternative communication path, allowing the cleaner to be controlled even if the primary cable connection was impractical or unavailable.

186. Therefore, it is my opinion that Cui and Fu-007 render Claim 16 obvious.

C. Ground 1C: Claims 10 and 17 are Unpatentable over Cui and Hsu

1. Hsu

187. Hsu (EX1011) is analogous art to the '207 Patent because Hsu addresses autonomous robotic cleaners that display cleaning coverage for user monitoring, using cameras to detect environment conditions. Hsu, Abstract, [0018]; EX1001, Abstract, 1:26-31, 9:26-47. Specifically, while Hsu describes a cleaning robot generally, a POSITA would have considered Hsu to be analogous art because like the '207 Patent, Hsu operates in the same field of endeavor—autonomous mobile surface cleaning robots—and address the identical problem: navigating a bounded area to ensure complete cleaning coverage while providing user feedback. *See* Hsu, Abstract, [0018]-[0022], [0033]-[0034], [0037]-[0038], FIGS.1-5. Additionally, Hsu explicitly states its technology “is not limited to indoor spaces,” demonstrating applicability to outdoor pool cleaning environments like the '207 Patent’s system. Hsu, [0019].

188. Hsu discloses a cleaning robot that includes **environment information detection device 10**, which can be “a camera, a video camera,” and **map construction module 20** that constructs “an environment map based on the

environment information detected by the environment information detection device.” Hsu, Abstract, [0017]-[0018], [0037]-[0038], Claim 1, FIGs. 1, 5 (S2) (annotated below).

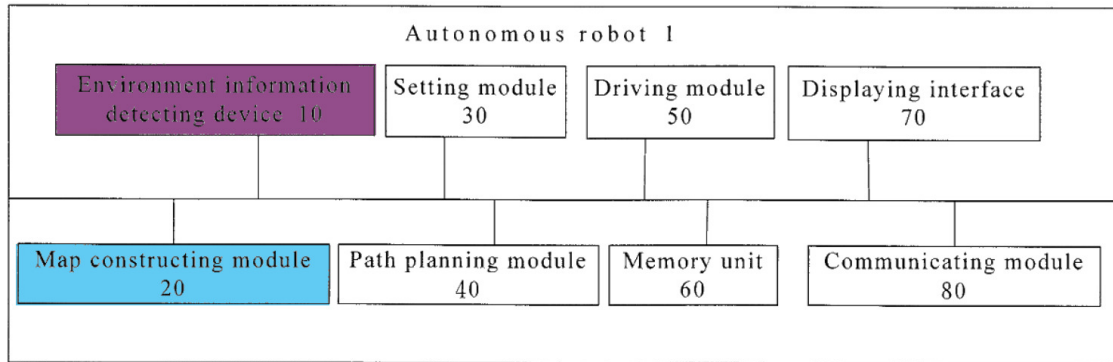


FIG. 1

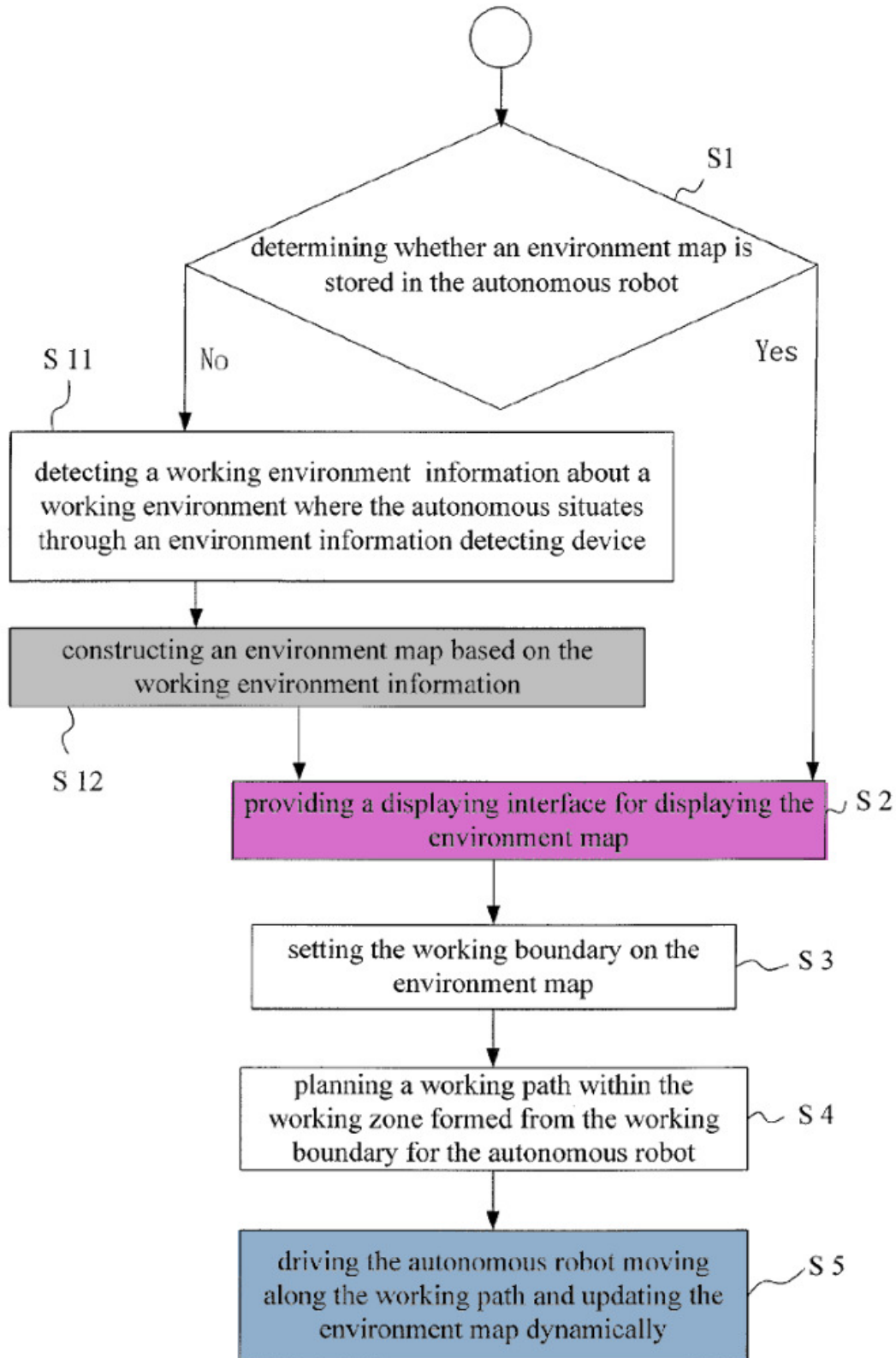


FIG. 5

189. Hsu's environment map 120 shows the working environment including working zones, and is "updated dynamically" based on "real-time working environment information detected by the environment information detection device" while the robot is moving, which "increase[s] the accuracy of the environment map" and allows the robot to "avoid...obstacles." Hsu, [0020], [0033]-[0034], Claims 3, 6, 8-9, 12, 15-16, FIGS. 2-3, 5 (**S5**) (annotated above).

190. Hsu describes "environment map 120 can be transmitted to the display screen on an external **electronic device 130** or an **electronic device 130a** by...**autonomous robot 1** via a communication platform 110." Hsu, [0021], [0028], Claim 7, FIGS. 4-5 (**S2**) (annotated below).

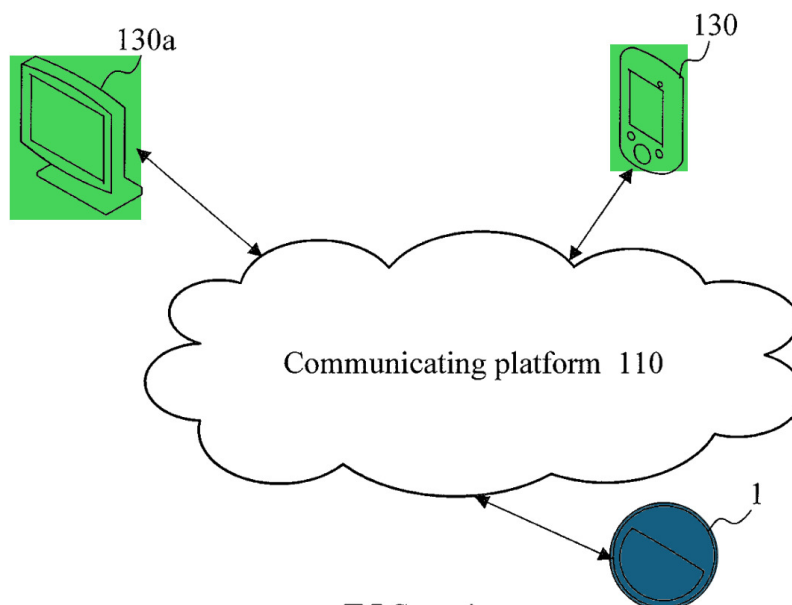


FIG. 4

2. Reasons for Combining Cui and Hsu

191. Both Cui and Hsu disclose autonomous cleaning robots using cameras

and controllers to monitor and display cleaning progress to users. Cui provides interface 16 so that “the working status of the cleaner can be seen at a glance,” recognizing the value of visual feedback about cleaning progress. Cui, p.6. Hsu similarly provides a display interface showing an environment map that is “updated dynamically” during cleaning operations. Hsu, [0018]-[0022], [0033]-[0034]. A POSITA would have been motivated to combine the complementary teachings of Cui and Hsu to achieve improved visual monitoring of autonomous cleaning operations.

192. A POSITA would have been motivated to apply Hsu’s camera-based map construction approach to Cui’s system for the following reasons. First, this modification would have advanced Cui’s functionality to provide visual information to users. Cui’s camera 5 already captures images “of the areas to be cleaned,” providing visual data showing actual surface conditions. Cui, pp.5-7. Using camera-captured visual data to construct the graphical depiction (per Hsu) would have allowed more accurate representation of the environment cleanliness than Cui’s motor-tracking formula.

193. Second, a POSITA would have been motivated to make such modification to enhance Cui’s “high reliability.” Cui, Abstract, p.5. In the modified system, Cui’s camera would continuously capture images of the areas to be cleaned

and provide dynamically updated visual ground truth of pool surface conditions, thereby “increase[ing] the accuracy of the environment map.” Hsu, [0020], [0033]-[0034], Claims 3, 6, 8-9, 12, 15-16, FIG. 5. This would efficiently use Cui’s existing camera for dual purposes: debris detection (per Cui’s existing functionality) and coverage verification (per Hsu’s functionality). Moreover, Hsu’s “real-time working environment information” would have allowed the cleaner to avoid obstacles and increase reliability. Hsu, [0020].

194. A POSITA would have reasonably expected success because Cui already has the necessary hardware—camera 5 and controller 7 with image processing and storage capabilities. Cui, pp.5-7, FIGS. 5-6. The modification would have involved software changes to use Hsu’s camera image analysis, instead of Cui’s pool area simulation based on calculations from wheel rotation and motor step angles (Cui, p.7) for coverage determination. In my opinion, that modification would be a straightforward task yielding the predictable result of camera-based coverage display.

3. Claim 10

195. Claim 10 depends from Claim 2. In my opinion, the Cui-Hsu combination discloses or suggests Claim 10.

196. Cui’s computer 7 includes “a human-machine interface 16” that

displays “the cleaned area...denoted by light blue, and the area that has not been cleaned yet...denoted by dark blue so that the working status of the cleaner can be seen at a glance” based on a motor-tracking formula. Cui, pp.6-7, Claim 3, FIG. 4.

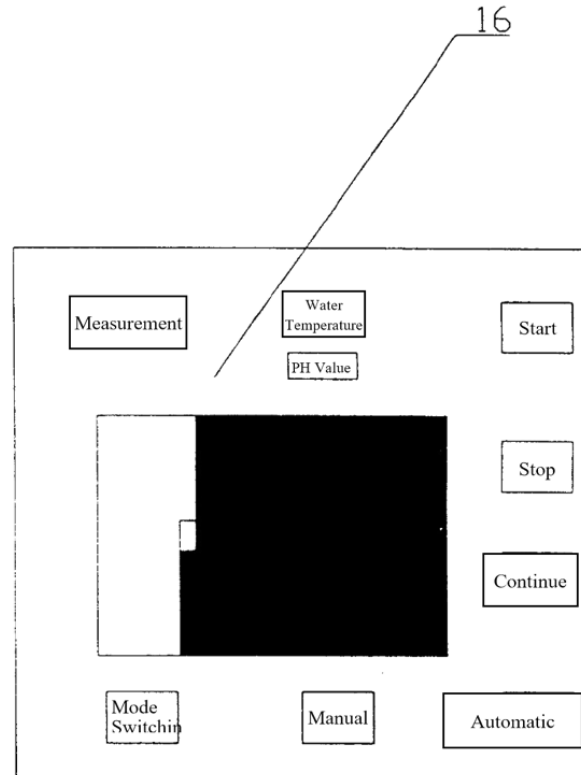
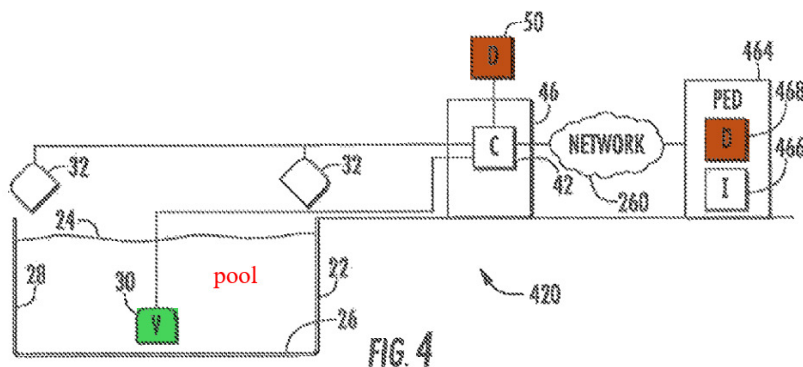
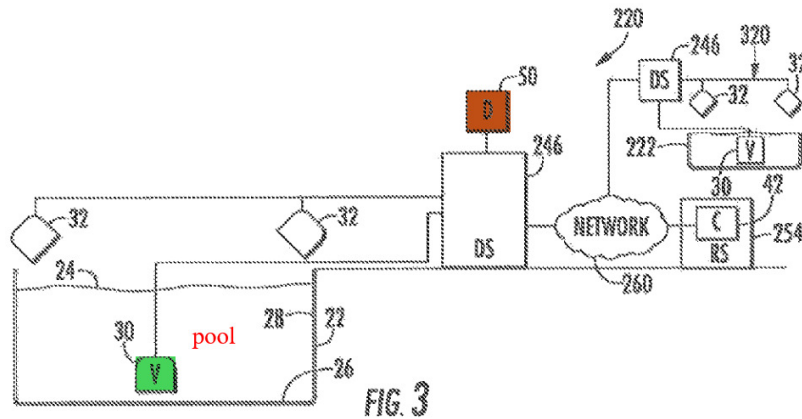
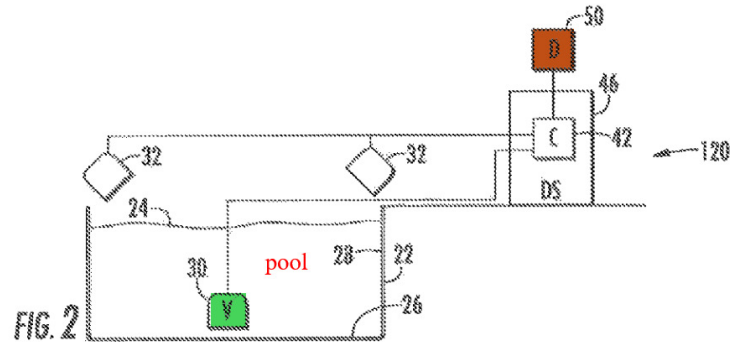


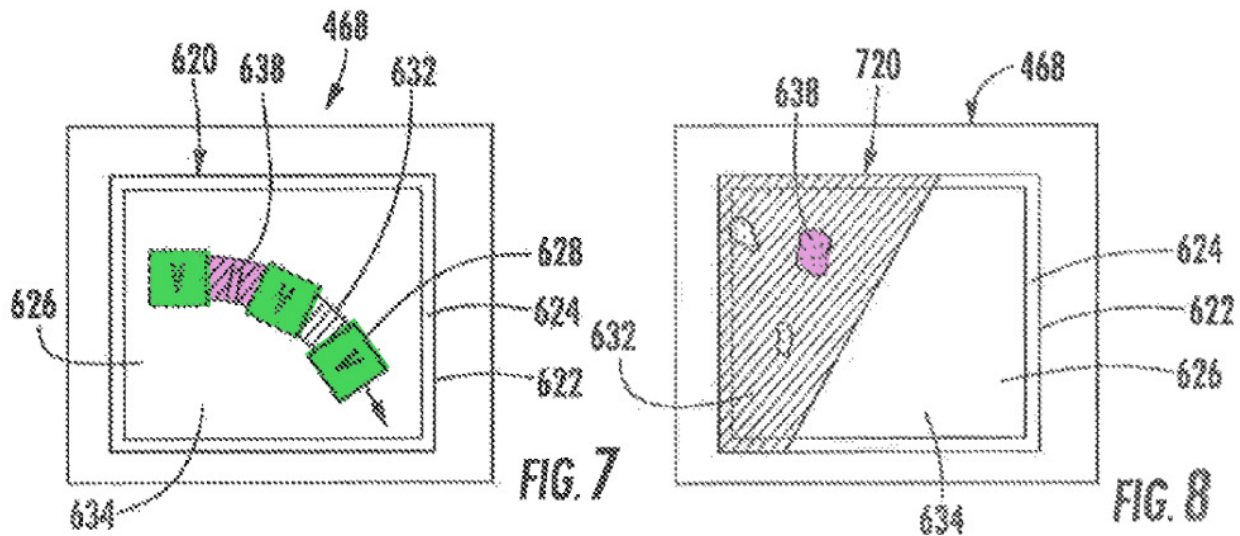
FIG. 4

197. Computer 7 is physically separated and accordingly remote from the pool cleaner configured to perform cleaning operations in water-filled pools. Cui, pp.4-5, FIGS. 5-6; *see also* §VII.A.2.a, VII.A.5-VII.A.6, (1[pre], Claims 5-6). Interface 16 of computer 7 displays the working status of the cleaner to a user. Cui, p.6, FIG. 4. A POSITA would have understood that interface 16 is outside the pool and physically separated and accordingly remote from the pool cleaner, constituting

a remote device. This is consistent with the '207 Patent that describes **display 50/468** is outside the pool and physically separated and remote from **vehicle 30/830**. EX1001, 5:27-51, FIGS. 2-5, 9 (annotated below).



has been currently cleaned.” EX1001, 5:52-61, FIGS. 7-8 (annotated below).



199. As explained in §VII.C.1, Hsu discloses a cleaning robot that includes environment information detection device 10, which can be “a camera, a video camera,” and map construction module 20 that constructs “an environment map based on the environment information detected by the environment information detection device.” Hsu, Abstract, [0018], Claim 1, FIG. 1 (annotated below).

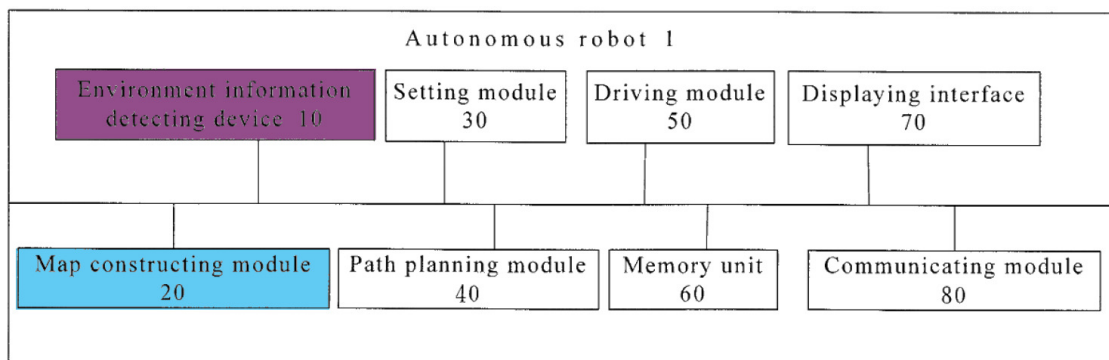


FIG. 1

200. As explained in §VII.C.1, Hsu further describes that the environment

map displays the environment including working zones and is “updated dynamically” during cleaning, and that “environment map 120 can be transmitted to the display screen on an external **electronic device 130** or an **electronic device 130a** by... **autonomous robot 1** via a communication platform 110.” Hsu, [0018]-[0022], [0034], FIGS. 2, 4-5 (annotated below).

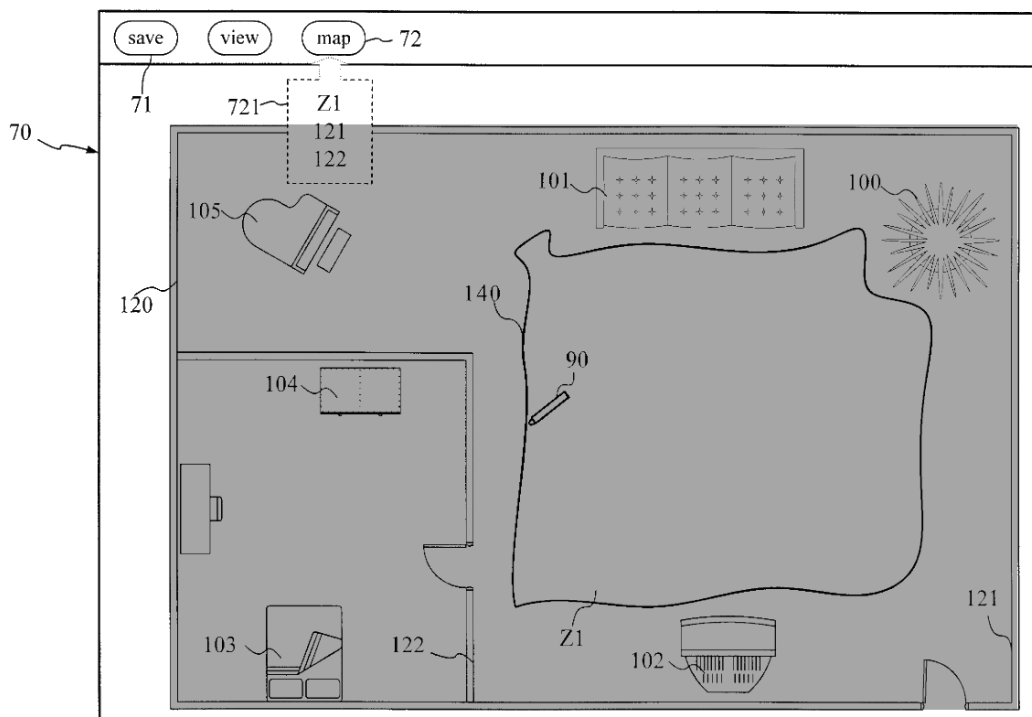


FIG. 2

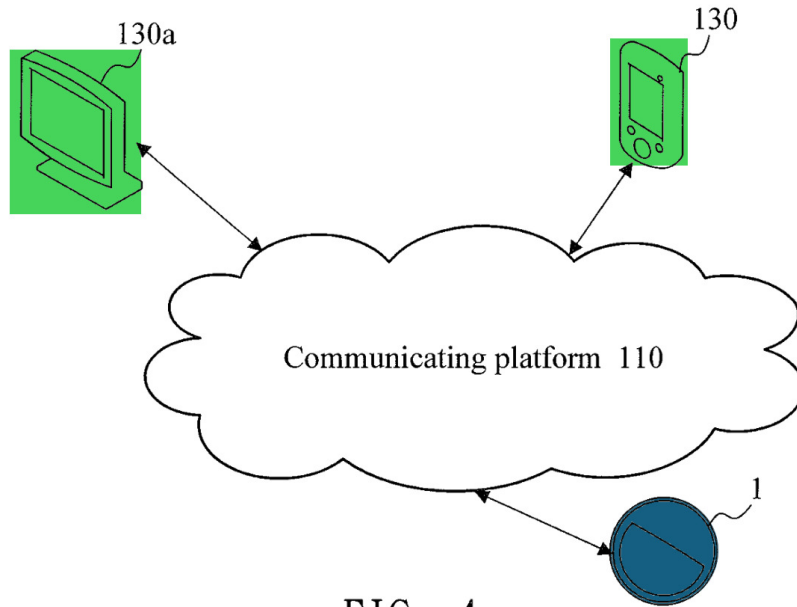


FIG. 4

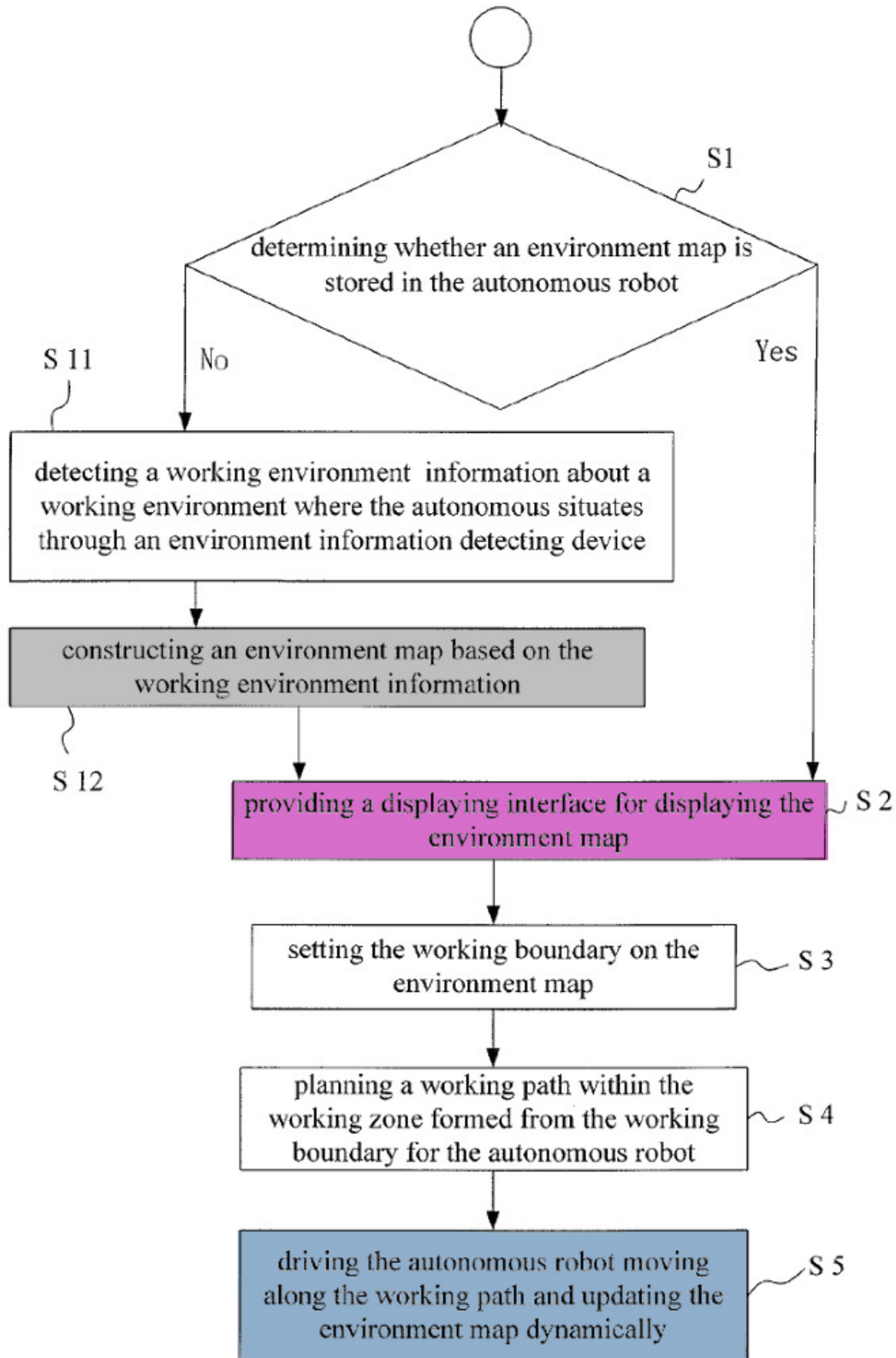


FIG. 5

201. As explained in §VII.C.2, a POSITA would have been motivated to apply Hsu’s approach of map construction from camera data to Cui’s system. In the modified system, Cui’s controller 7 would receive images from camera 5 (Cui, pp.6-7), process the images to determine a control action for pool cleaner (equipment) operation, and execute that control action by constructing and presenting a graphical depiction showing cleaned versus uncleaned areas based on the images (per Hsu’s approach of map construction “based on the environment information detected” when a camera is the detection device). This camera-based graphical depiction—a dynamically updated map showing cleaned versus uncleaned areas—would be presented on interface 16 (remote device) and transmitted to external devices 130/130a (remote device) as the control action. Cui, p.6; Hsu, [0021]-[0022].

202. As explained in §VII.C.2, a POSITA would have reasonably expected success in making such modification to achieve predictable results. Cui already has the necessary hardware—camera 5 and controller 7 with image processing and storage capabilities. Cui, pp.5-7, FIGS. 5-6. Hsu demonstrates that dynamically updated camera-based maps display cleaning coverage in robotic cleaning applications. Hsu, Abstract, [0018], [0020], [0033]-[0034]. The modification would have only involved software changes to use Hsu’s camera image analysis for coverage determination, which would be a straightforward task for a POSITA

yielding the predictable result of camera-based coverage display. Since Cui already discloses that cameras and computers function effectively for the pool cleaner (Cui, p.6), a POSITA would have expected that Hsu’s data processing algorithms—which simply convert sensor inputs into a graphical map—would have functioned with equal success in the combined system.

203. Therefore, it is my opinion that Cui and Hsu render Claim 10 obvious.

4. Claim 17

204. Claim 17 depends from claim 12. In my opinion, the Cui-Hsu combination discloses or suggests claim 17.

a. 17[a] “The method of claim 12, wherein generating the control response comprises prompting a user on a remote device, and”

205. It is my opinion that the Cui-Hsu combination discloses or suggests 17[a].

206. Cui, as modified by Hsu, presents a graphical depiction—a dynamically updated map showing cleaned versus uncleaned areas during cleaning operations—on interface 16 (remote device) based on camera-captured visual data. Cui, pp.6-7, FIG. 4; Hsu, [0020], [0033]-[0034], Claims 3, 6, 8-9, 12, 15-16, FIGS. 2-3, 5; *see also* §VII.C.2 (Claim 10). Additionally, Cui teaches that this same remote interface 16 displays interactive control icons (e.g., “Automatic,” “Manual,” “Start,”

“Continue”) that allow the user to control the cleaner. Cui, p.6, FIG. 4 (annotated below).

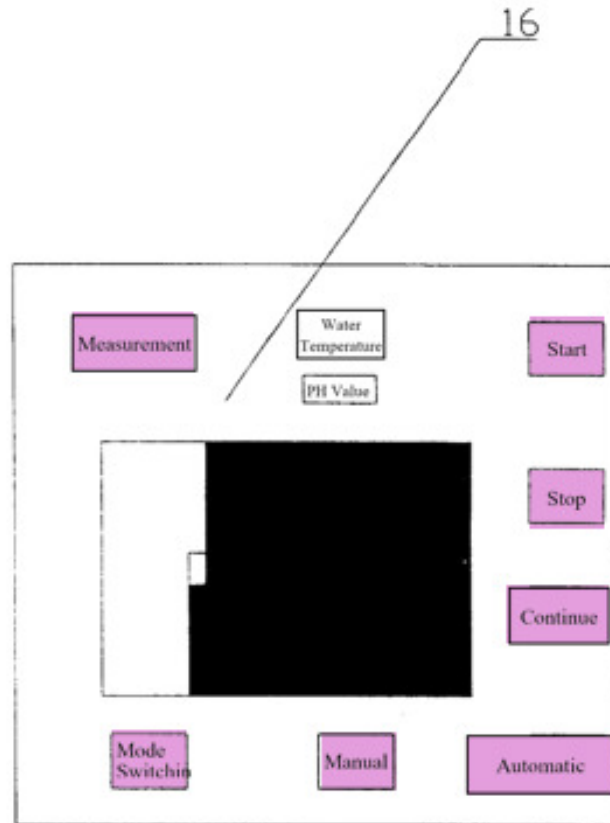


FIG. 4

207. A POSITA would have been motivated to combine Cui and Hsu, as explained in §VII.C.2. A POSITA would have understood or found it obvious that dynamically updated the map displayed on interface 16 (remote device) in the Cui-Hsu combination and displaying these actionable control icons on the remote device constitutes “prompting a user” because the interface explicitly presents the active status information and specific options, soliciting user engagement and inviting

users to select a command (e.g., prompting the user to decide whether to “Stop” or switch to “Manual” mode based on the visual status map). Thus, the act of generating the display with these control options serves as the control response that prompts the user. A POSITA would have understood that in Human-Machine Interface (HMI) design, the simultaneous presentation of real-time status data (the map indicating uncleaned areas) alongside executable command options (the control icons) functions as a solicitation for operator input. By visualizing the incomplete cleaning task and immediately providing the specific tools to address it, the system effectively queries the user’s intent, which constitutes a “prompt” for a control response on a remote device.

b. 17[b] “wherein the method further comprises receiving a control input from the user on the remote device for controlling a piece of equipment of the swimming pool or spa.”

208. In my opinion, Cui discloses or suggests 17[b].

209. As explained above in §VII.C.4.a (17[a]), Cui’s interface 16 includes interactive control icons allowing user selections. A POSITA would have understood that Cui’s system receives a control input from the user when the user interacts with these prompted icons (e.g., clicking “Start” or “Manual”) on the remote device. This received input is used for controlling the pool cleaner (equipment), as Cui explicitly states that these commands determine the operation (automatic/manual/stop) of the

cleaner. Cui, p.6, FIG.4.

210. Therefore, it is my opinion that Cui and Hsu render Claim 7 obvious.

D. Ground 2A: Claims 1-3, 5-7, 12, 14, and 19 are Unpatentable over Knoll

1. Knoll

211. Knoll (EX1006), which is analogous art and in the same field as the '207 Patent, discloses an autonomous robotic pool cleaning vehicle with camera-based distance detection. Knoll, Title, Abstract, [0001]-[0002], [0007], [0021], [0027], Fig. 1 (reproduced below).

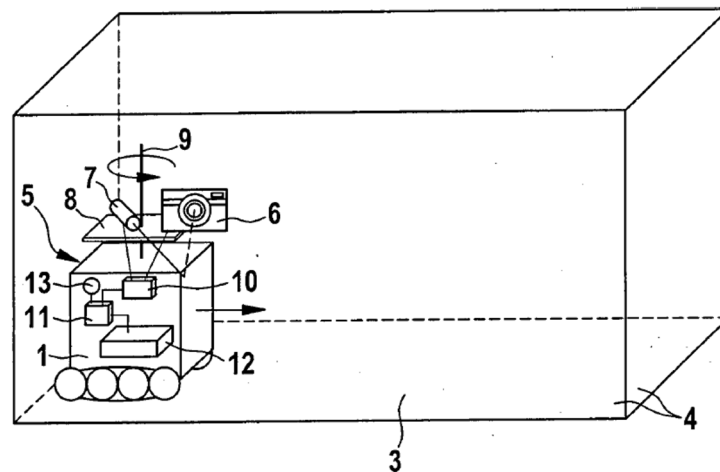


Fig. 1

212. Knoll's system includes robotic vehicle 1 with drive means 12, distance-determining device 5 comprising digital camera 6 and light beam source 7 rotatably mounted on mounting plate 8, and control unit 11 for controlling the drive means. Knoll, [0007], [0027]-[0028], Claim 1, FIG.1. The robotic vehicle is "a pool

robot with a suction and/or filter and/or cleaning device” that operates on working area 3 formed by the pool bottom and delimited by boundary surface 4 (pool walls). Knoll, [0007], [0027]-[0028], Figs. 1-2.

213. Knoll’s camera 6 captures images of the boundary surface, which evaluation unit 10 processes to derive “quasi-continuously determined smallest distance measurement values” relative to the boundary. Knoll, [0028]. Control unit 11 uses these image-derived values to “automatically calculate[] a trajectory” and generate control signals that “control[] the drive means 12” to move the vehicle “away from or toward” the boundary to maintain a “defined distance.” Knoll, [0028], Claim 2, FIG. 2 (reproduced below).

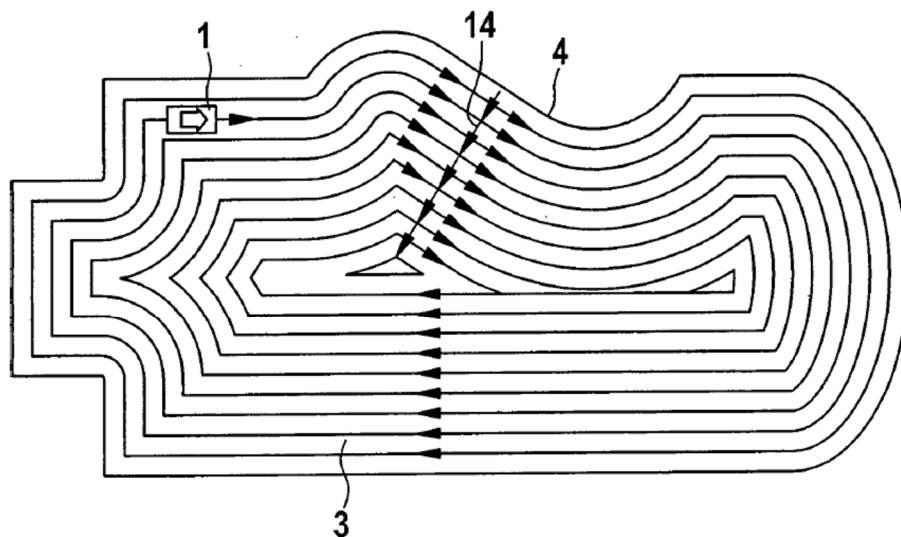


Fig. 2

2. Claim 1

214. In my opinion, Knoll discloses or suggests Claim 1.

a. **1[pre] “A self-propelled pool cleaning system for cleaning debris from a submerged surface of a swimming pool, comprising”**

215. It is my opinion that Knoll discloses or suggests 1[pre].

216. Knoll discloses an “autonomous robotic vehicle 1 designed as a pool cleaning vehicle” with “drive means (12) for driving and steering” and a **control unit 11** that controls **drive means 12** and is “designed to automatically calculate a trajectory.” Knoll, Abstract; [0027]-[0028]; Claims 2, 4, 14, FIG. 1 (annotated below).

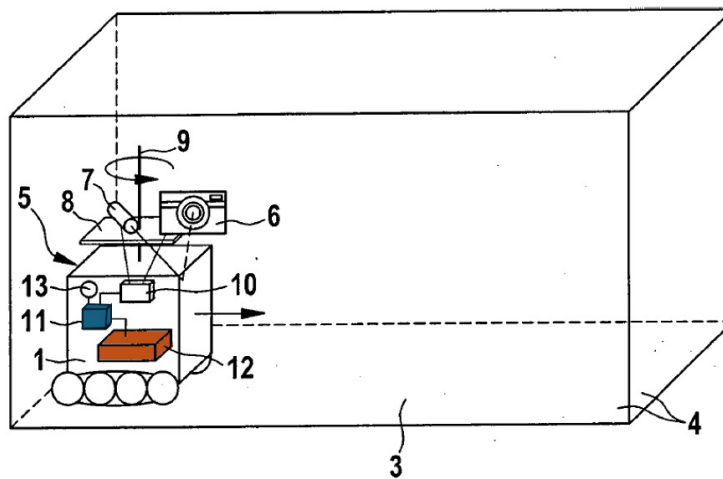


Fig. 1

217. Knoll’s robotic vehicle is a self-propelled pool cleaning system because it is a “pool robot with a suction and/or filter and/or cleaning device” and its “drive means” propels the vehicle under the control of the control unit. Knoll, [0007], [0028].

218. Knoll’s robotic vehicle equipped with a suction/filter/cleaning device,

cleans debris from a submerged surface of a swimming pool because it operates on a working area 3 formed by the pool bottom and “delimited by four pool walls...forming a circumferential boundary surface 4.” Knoll, [0021], [0027]–[0028], FIG. 1 (below). A POSITA would have understood that the pool bottom and walls are submerged when the pool is in normal service, and pool-cleaning robots are intended to operate in filled pools, so the device cleans debris from submerged pool surfaces.

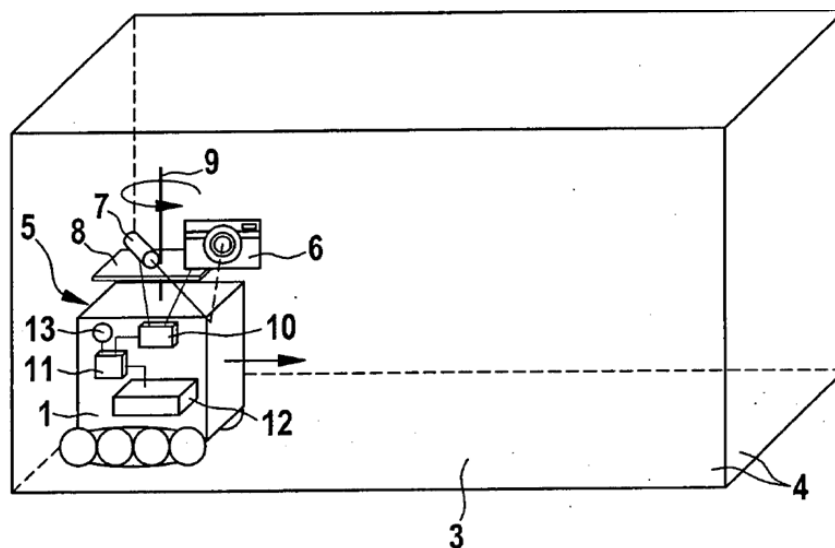


Fig. 1

b. 1[a] “a. a vehicle body”

219. In my opinion, Knoll discloses or suggests 1[a].

220. Knoll’s robotic vehicle 1 (pool cleaning system) includes various components: drive means 12 “for generating propulsion and for steering,” control unit 11 that “controls the drive means” and is “designed to automatically calculate a

trajectory of the robotic vehicle (1),” and “suction and/or filter and/or cleaning device.” Knoll, Abstract, [0007], [0021], [0027]-[0028], Claims 1-2, 14, FIG.1 (below). A POSITA would have understood that Knoll’s robotic vehicle—comprising the integrated physical structure with these components—includes a “vehicle body” hosting these components.

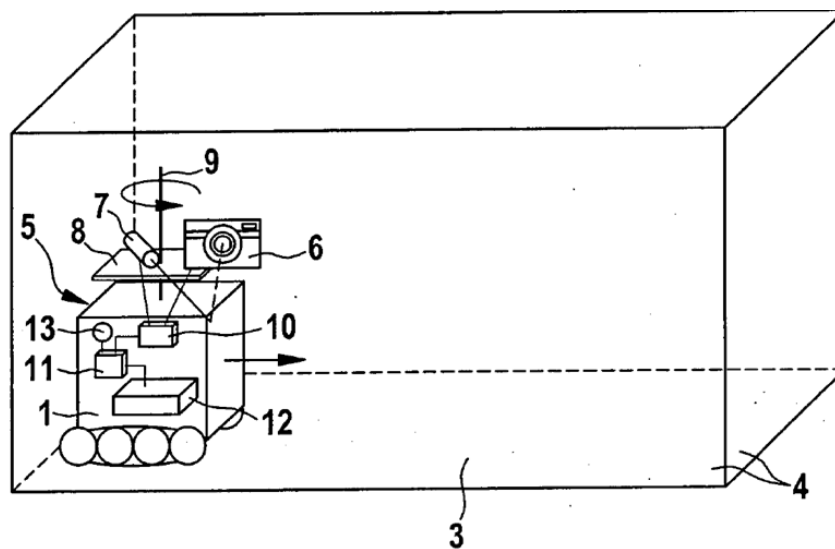


Fig. 1

c. 1[b] “b. means for moving the vehicle body within the swimming pool”

221. It is my opinion that Knoll discloses or suggests 1[b].

222. The format and content of 1[b] invokes AIA 35 U.S.C. §112(f) or pre-AIA 35 U.S.C. §112¶6. As explained in §VI.C, the recited function of this means-plus-function limitation is “moving the vehicle body within the swimming pool,” and the corresponding structures are wheels, rollers, tracks, other surface contacting

members powered by a motor, a vacuum, or a liquid jet. EX1001, 3:33-45, 10:15-17, FIGS. 9-10.

223. Knoll's Fig. 1 (annotated below) shows robotic vehicle 1 with **drive means 12** and **wheels** contacting the pool bottom surface within working area 3. Knoll, Fig. 1.

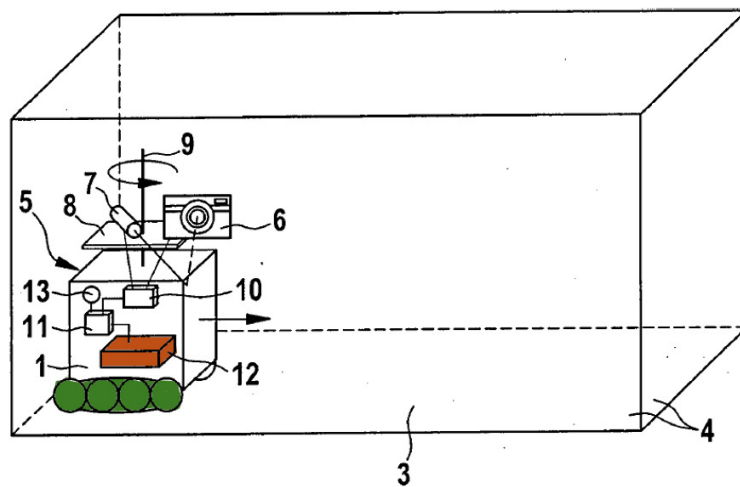


Fig. 1

224. Knoll describes that “drive means (12) for driving and steering the robotic vehicle (1)” are configured “for generating propulsion and for steering the robotic vehicle 1.” Knoll, Abstract, Claims 1, 14, [0028]. A POSITA would have understood that Knoll’s drive means 12 comprises motor(s) powering the wheels, because generating propulsion and steering for a wheeled robotic vehicle would have included motor-driven wheel rotation. Knoll’s drive means 12 and wheels satisfy the corresponding structure disclosed in the ’207 Patent because both use wheels that

contact the pool's submerged surfaces and are powered by a motor to propel the vehicle body. Specifically, the '207 Patent discloses wheels that propel the vehicle "along the submerged pool surfaces" and are "powered by a motor" (EX1001, 3:33-39), and Knoll similarly discloses wheels (shown in Figure 1) that contact the pool bottom surface (a submerged surface) and are powered by motor(s) (as part of drive means 12) to move robotic vehicle 1. Knoll's motor-powered wheel structure performs the claimed function of "moving the vehicle body within the swimming pool."

d. 1[c] "c. a filter configured to retain debris collected from the submerged surface"

225. It is my opinion that Knoll discloses or suggests 1[c].

226. Knoll discloses this limitation because its pool cleaning robot includes "a filter device and/or suction device." Knoll, [0007], [0021]. Knoll describes its robot operates on "working area 3...formed by the bottom of the pool" and its control unit is "located inside the robotic vehicle in a waterproof housing." Knoll, [0008], [0027].

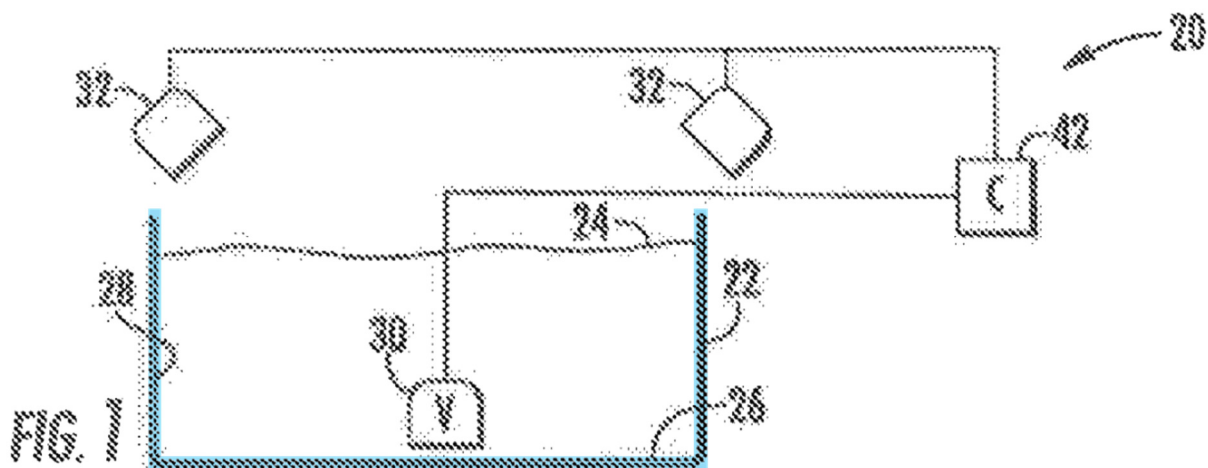
227. A POSITA would have understood that Knoll's suction device draws water containing debris from the pool's submerged surfaces by suction, and the filter device retains this collected debris, because Knoll's robot operates on the bottom of the pool and has "waterproof housing" for its control unit (Knoll, [0008]), and the

filters in pool cleaning systems, like Knoll's, capture and retain debris while allowing clean water to pass through, preventing debris from recirculating back into the pool. A POSITA would have recognized that the inclusion of a "filter device" on a submerged mobile cleaner inherently requires a configuration capable of separating and holding solid particulates from the water stream generated by the suction device, as this is the fundamental mechanism by which such robotic systems achieve the described cleaning of the pool bottom.

e. 1[d] "d. at least one camera for capturing an image of at least a first object within the swimming pool"

228. It is my opinion that Knoll discloses or suggests 1[d].

229. While the '207 Patent does not explicitly define "first object," it describes that "[i]n other implementations, cameras 32 merely capture images of submerged surfaces 26, 28 of pool 22," which are the bottom and side walls of the pool. EX1001, 3:53-55; FIG. 1 (annotated below).



230. Consistent with this description, Knoll teaches capturing images of substantially similar features—specifically, boundary surfaces/lines within the pool.

231. Specifically, Knoll’s robotic vehicle 1 includes **camera 6** positioned to observe “boundary line” and/or “boundary surface 4” formed by pool walls that delimit “working area 3.” Knoll, [0018], [0028], FIG. 1 (annotated below).

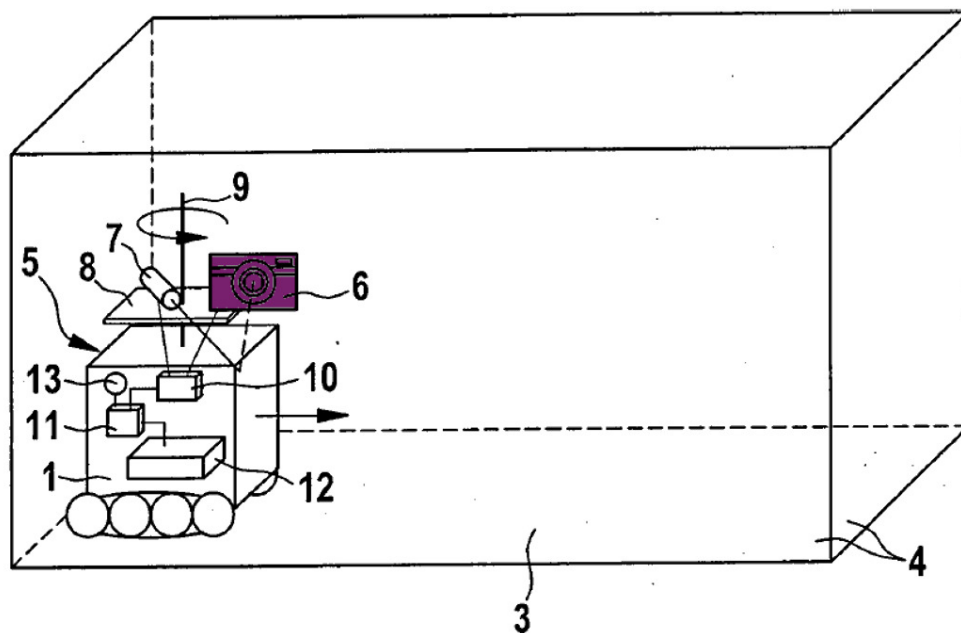


Fig. 1

232. Knoll describes that “a light beam is focused on the boundary line or boundary surface and **observed with a camera**,” and explains that “the angle at which the light beam is **observed** changes and thus the position of **its image** on the camera’s photo sensor changes” as the “distance of the boundary line or the boundary surface (measurement object) from the sensor (e.g., a camera) changes.” Knoll, [0018]. Knoll explains that the boundary line/surface can be “arranged at a distance

from the outer boundaries of the working area” and thus within the pool. Knoll, [0007]. Knoll also describes a “digital camera” detecting “obstacles” (first object) within the working area as “the obstacles reflect the light beam into the digital camera.” Knoll, [0015].

233. A POSITA would have understood that Knoll’s camera captures images of the boundary line/surface or obstacle (first object within the swimming pool) within the pool, because the “image” on the photo sensor of the camera includes the light reflected off the boundary line/surface or obstacle, and thus would include the surrounding surfaces of the pool. Knoll, [0015]. Furthermore, Knoll explicitly discloses that the distance-determining device can operate via “a time-of-flight measurement of the, preferably time-modulated, light beam.” Knoll, [0019]; *see also id.*, [0016] (discussing “time-of-flight measurement of the measurement signal”). A POSITA would have understood that an optical sensor performing time-of-flight (ToF) measurements using reflected light constitutes a type of “camera”—specifically, a depth camera, 3D camera, or LiDAR (Light Detection and Ranging) system. A POSITA would have further understood that such ToF systems capture an “image” (e.g., a depth map, 3D point cloud, or intensity image) of the target object (the boundary or obstacle) to determine its distance and geometry. Therefore, when Knoll describes using a sensor to detect reflected light for determining spatial

characteristics, it is describing the capture of an image—specifically a range image—of the physical obstacles or boundaries (objects) present in the environment. Thus, Knoll’s disclosure of light-based time-of-flight measurements further satisfies the limitation of a camera capturing an image of an object within the pool.

f. 1[e][i] “e. a controller (i) in electronic communication with the at least one camera and”

234. In my opinion, Knoll discloses or suggests 1[e][i].

235. Knoll discloses a “control unit 11” that constitutes the claimed “controller.” Knoll, [0028]. Control unit 11 functions as a controller because it “has a controlling effect on the... drive means 12 for generating propulsion and for steering the robotic vehicle 1” and “automatically determine[s]” the vehicle’s trajectory. Knoll, [0028]-[0029].

236. Knoll’s control unit 11 (controller) is in electronic communication with the at least one camera (digital camera 6). Knoll, [0028]. As shown in FIG. 1, Knoll’s **evaluation unit 10** (part of **control unit 11**) is connected to **camera 6** via a **wire/cable**, so that evaluation unit 10 can receive the camera’s image data. Knoll, [0028], FIG. 1 (annotated below).

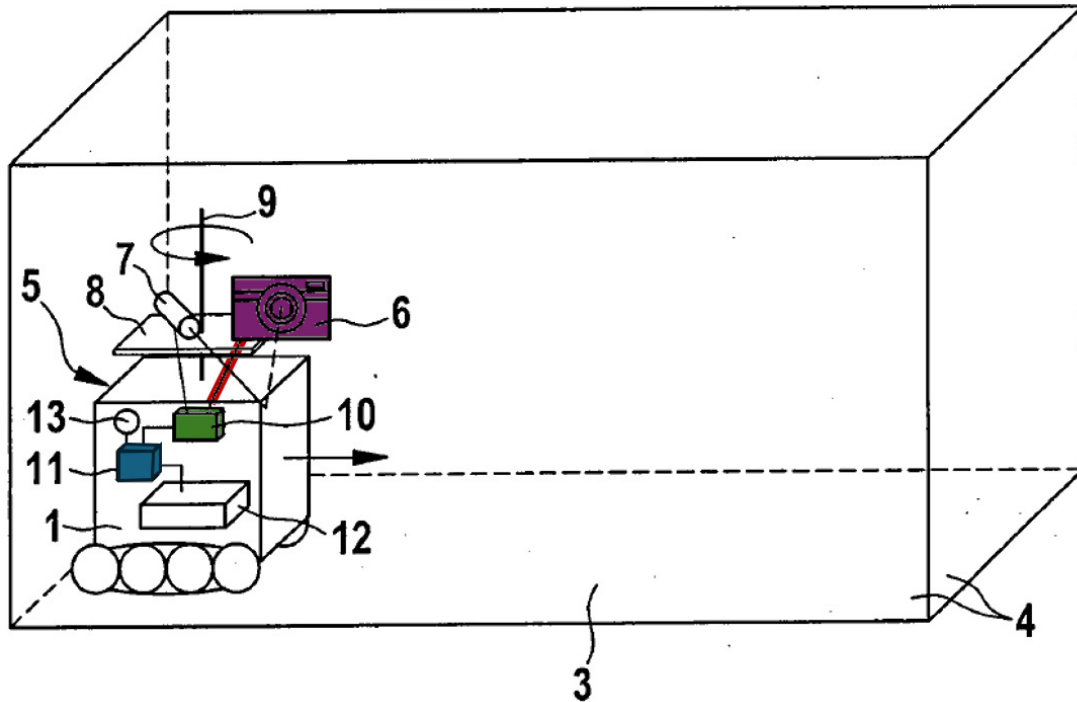


Fig. 1

237. Knoll describes that its “distance-determining device...comprises a...digital camera 6” and includes “an evaluation unit 10 for evaluating or determining the measured distance values” derived from the camera. Knoll, [0028]. Crucially, Knoll states that “the evaluation unit 10 is part of a control unit 11.” *Id.* Knoll describes that its “distance-determining device uses the rotating light beam source and the rotating **camera** to determine the distance to the boundary line or boundary surface by triangulation” and that the device includes “an **evaluation unit 10** for evaluating or determining the measured distance values,” with “the evaluation unit 10 [being] part of a **control unit 11**.” Knoll, [0028]. Knoll further explains that “a light beam is focused on the boundary line or boundary surface and observed with

a camera,” and that as “the angle at which the light beam is observed changes...the **position of its image on the camera’s photo sensor changes,**” with “[t]he distance...then **calculated from the change in position.**” Knoll, [0018]. A POSITA would have understood that control unit 11 is in electronic communication with camera 6, because, to calculate distance values from images captured on the camera, evaluation unit 10 (part of control unit 11) would receive data from camera 6 for processing. Knoll, [0018], [0028].

- g. 1[e][ii] “(ii) 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.”**

238. In my opinion, Knoll discloses or suggests 1[e][ii].

239. Knoll teaches that control unit 11 “controls the drive means 12 as a function of...quasi-continuously determined smallest distance measurement values” to the boundary line or boundary surface (the measurement object). Knoll, [0028]. The “at least one control signal” is generated “in response to the captured image” because, as explained in §VII.D.2.e (1[d]), the distance measurement values that form the basis for the control signal generation are derived from images captured by digital camera 6 observing the boundary surface (the “first object” or “measurement object”).

240. Knoll explains that the “trajectory for the robotic vehicle 1...was

automatically determined by the control unit 11 on the basis of the determined distance to the boundary surface 4.” Knoll, [0029], FIG. 2.

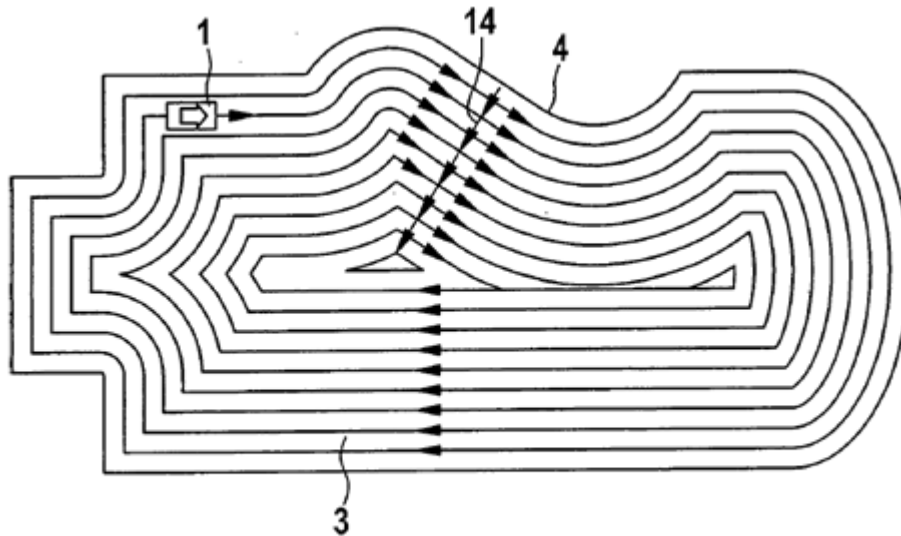


Fig. 2

241. A POSITA would have understood that the trajectory in Figure 2—comprising path segments that follow the contour of boundary line/surface 4 at different offsets—results from control unit 11 repeatedly adjusting drive means 12 based on the measured distance so as to maintain an appropriate spacing from boundary line/surface 4 while traversing working area 3. Knoll, [0029], FIG. 2. A POSITA also would have understood that, to maintain a desired spacing from the boundary line/surface 4 that delimits working area 3, Knoll’s control unit 11 would generate drive-control signals that adjust vehicle motion based on the measured distance—causing the vehicle body to *move away* from the boundary line/surface

(first object) when the measured distance becomes too small (vehicle approaching the boundary) ***and toward*** the boundary line/surface when the measured distance becomes too large (vehicle drifting away). *Id.* In this way, Knoll’s control unit 11 is configured to generate, in response to the images captured by camera 6, at least one control signal that causes movement of the body within the swimming pool to, or away from, the first object, where the first object is Knoll’s boundary line/surface 4. A POSITA would have recognized that this “wall-following” or “contouring” behavior relies on a closed-loop feedback mechanism where the error signal (the difference between current distance and target distance) directly drives the steering actuation, allowing corrective movements both “to” and “away from” the boundary to correct for drift and navigation errors.

242. Additionally, Knoll teaches generating control signals to cause movement “away from” a detected obstacle (first object). Knoll, [0015]. Knoll explains that its camera detects obstacles because they “reflect the light beam into the digital camera,” and in response, the control unit is configured so that “obstacles are bypassed” or the robot “drive[s] around the obstacle.” Knoll, [0015]. A POSITA would have understood that to “bypass” or “drive around” a detected obstacle (first object), the control unit would generate signals causing the vehicle body to move ***away*** from the obstacle to avoid collision. A POSITA would have understood that

the operational command to “bypass” an object located in the robot’s current path would require a vector change in the robot’s trajectory that increases the lateral distance between the robot and that object—effectively moving the body “away from” the potential collision point.

243. Therefore, it is my opinion that Knoll renders Claim 1 obvious.

3. Claim 2

244. In my opinion, Knoll discloses or suggests Claim 2.

a. 2[pre] “A pool system comprising”

245. It is my opinion that Knoll discloses or suggests 2[pre].

246. Knoll discloses a pool cleaning system operating within a swimming pool. *See* §VII.D.2.a (1[pre]). Specifically, Knoll describes the “autonomous robotic vehicle 1 designed as a pool cleaning vehicle” with a **control unit 11**, **drive means 12**, and distance-determining device 5 comprising a **camera 6** that operates within a swimming pool on working area 3 delimited by boundary surface 4. Knoll, [0027]-[0028], FIG. 1 (annotated below).

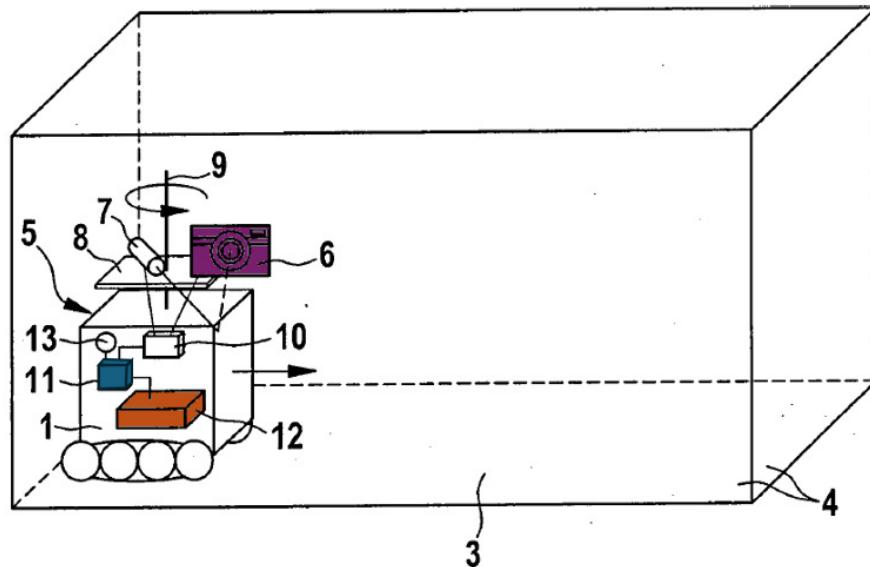


Fig. 1

247. A POSITA would have understood that Knoll’s integrated system of robotic vehicle with camera, control unit, and associated equipment operating within a swimming pool constitutes a “pool system” because Knoll’s system performs a specific function (cleaning) within a specific environment—a pool).

b. 2[a] “at least one piece of equipment for a swimming pool or spa”

248. In my opinion, Knoll discloses or suggests 2[a].

249. Knoll discloses control unit 11 as a controller for robotic vehicle 1. Knoll, [0028], Fig. 1; *see also* §VII.D.2.a (1[pre]). Knoll discloses an “autonomous robotic vehicle 1 designed as a pool cleaning vehicle” with “drive means (12)” that propel the vehicle under control of “control unit 11.” Knoll, Abstract; [0027]-[0028], Claims 2, 4, 14, FIG. 1; *see also* §VII.D.2.a (1[pre]). A POSITA would have

understood that Knoll’s robotic vehicle (and/or various components thereof) is “equipment for a swimming pool” because it operates within the swimming pool to clean pool surfaces. *See also* EX1001, Claims 1, 3 (reciting similar equipment of a pool system); §VII.D.2.a (1[pre]).

c. 2[b] “one or more cameras configured to capture video or images of at least a portion of a location including the swimming pool or spa”

250. In my opinion, Knoll discloses or suggests 2[b].

251. Knoll’s robotic vehicle 1 includes camera 6 that captures images of the boundary line/surface (a portion of a location) of the swimming pool and images of obstacles within the working area 3 “formed by the bottom of the pool” (a portion of a location) of the swimming pool. Knoll, Claim 8, [0015], [0018], [0027]-[0028], FIG. 1.; *see also* §VII.D.2.e (1[d]).

d. 2[c][i] “a controller in communication with the at least one piece of equipment and the one or more cameras”

252. It is my opinion that Knoll discloses or suggests 2[c][i].

253. Knoll discloses **control unit 11** as a controller for robotic vehicle 1. Knoll, [0028], FIG. 1 (annotated below); *see also* §§VII.D.2.a, VII.D.2.f (1[pre], 1[e][i]).

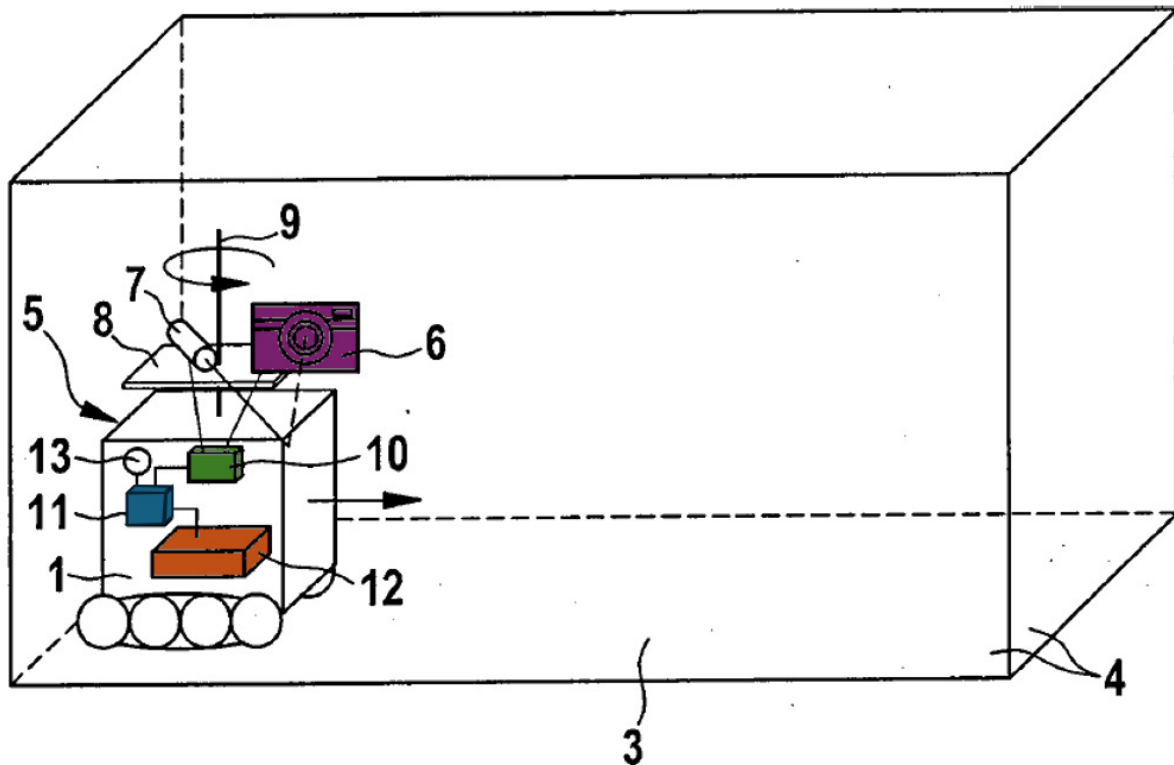


Fig. 1

254. Knoll's control unit controls **drive means 12** to move robotic vehicle 1 in the pool based on image-derived distance values. Knoll, [0028]–[0029], Fig. 2; *see also* §§VII.D.2.a, VII.D.2.g (1[pre], 1[e][ii]). A POSITA would have understood that, to control drive means 12, control unit 11 would be in communication with drive means 12, and thus with vehicle 1 (equipment) because drive means 12 is part of the vehicle.

255. Further, control unit 11 (controller) is in communication with **camera 6** to receive images. *See* §VII.D.2.f (1[e][i]).

- e. **2[c][ii] “the controller configured to receive visual data from the one or more cameras and determine a control action for the at least one piece of equipment based on the received visual data.”**

256. In my opinion, Knoll discloses or suggests 2[c][ii] because Knoll’s controller receives images (visual data) from camera 6, and determines and generates control signal (control action) to control movement of vehicle 1 (equipment) based on the images. *See* §§VII.D.2.f-VII.D.2.g (1[e][i]-1[e][ii]).

257. Knoll discloses a “control unit 11” that constitutes the claimed “controller.” Knoll, [0028]. Control unit 11 functions as a controller because it “has a controlling effect on the... drive means 12 for generating propulsion and for steering the robotic vehicle 1” and “automatically determine[s]” the vehicle’s trajectory. Knoll, [0028]-[0029].

258. Knoll’s control unit 11 (controller) is in electronic communication with the at least one camera (digital camera 6). Knoll, [0028]. As shown in FIG. 1, Knoll’s **evaluation unit 10** (part of **control unit 11**) is connected to **camera 6** via a **wire/cable**, so that evaluation unit 10 can receive the camera’s image data. Knoll, [0028], FIG. 1 (annotated below).

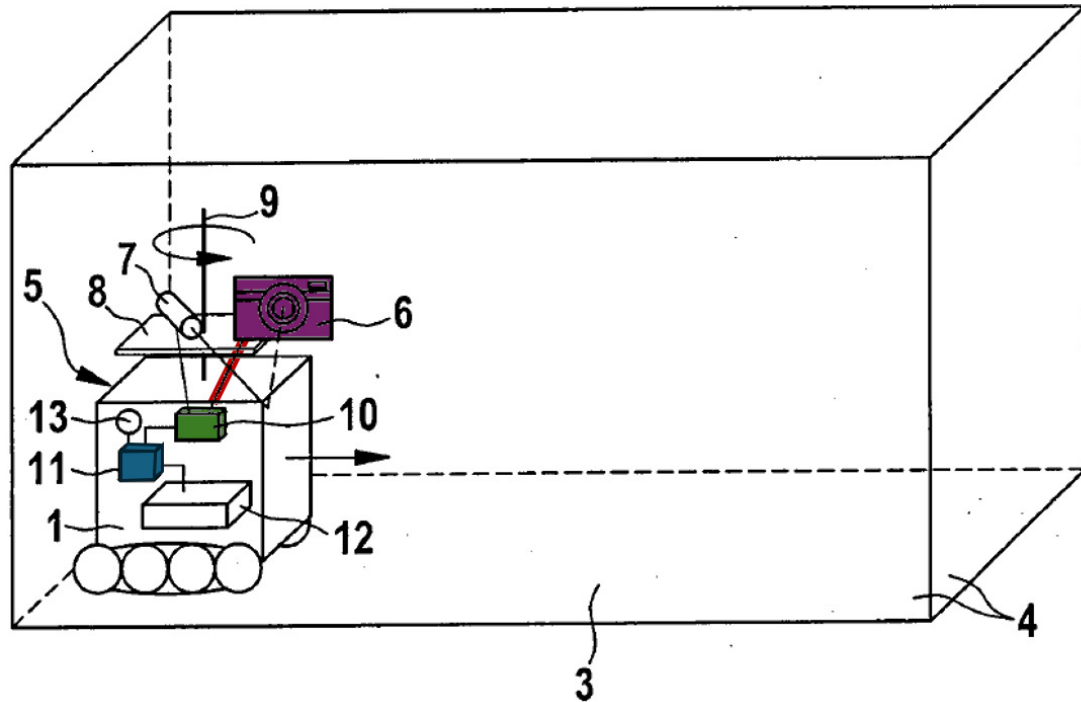


Fig. 1

259. Knoll describes that its “distance-determining device...comprises a...digital camera 6” and includes “an evaluation unit 10 for evaluating or determining the measured distance values” derived from the camera. Knoll, [0028]. Crucially, Knoll states that “the evaluation unit 10 is part of a control unit 11.” *Id.* Knoll describes that its “distance-determining device uses the rotating light beam source and the rotating **camera** to determine the distance to the boundary line or boundary surface by triangulation” and that the device includes “an **evaluation unit 10** for evaluating or determining the measured distance values,” with “the evaluation unit 10 [being] part of a **control unit 11**.” Knoll, [0028]. Knoll further explains that “a light beam is focused on the boundary line or boundary surface and observed with

a camera,” and that as “the angle at which the light beam is observed changes...the **position of its image on the camera’s photo sensor changes**,” with “[t]he distance...then **calculated from the change in position**.” Knoll, [0018]. A POSITA would have understood that control unit 11 is in electronic communication with camera 6, because, to calculate distance values from images captured on the camera, evaluation unit 10 (part of control unit 11) would receive data from camera 6 for processing. Knoll, [0018], [0028].

260. Knoll teaches that control unit 11 “controls the drive means 12 as a function of...quasi-continuously determined smallest distance measurement values” to the boundary line or boundary surface (the measurement object). Knoll, [0028]. The “at least one control signal” is generated “in response to the captured image” because, as explained in §VII.D.2.e (1[d]), the distance measurement values that form the basis for the control signal generation are derived from images captured by digital camera 6 observing the boundary surface (the “first object” or “measurement object”).

261. Knoll explains that “the previously described trajectory for the robotic vehicle 1...was automatically determined by the control unit 11 on the basis of the determined distance to the boundary surface 4,” so that “almost the entire working area 3,” and if desired the entire working area, can be covered. Knoll, [0029], FIG.

2.

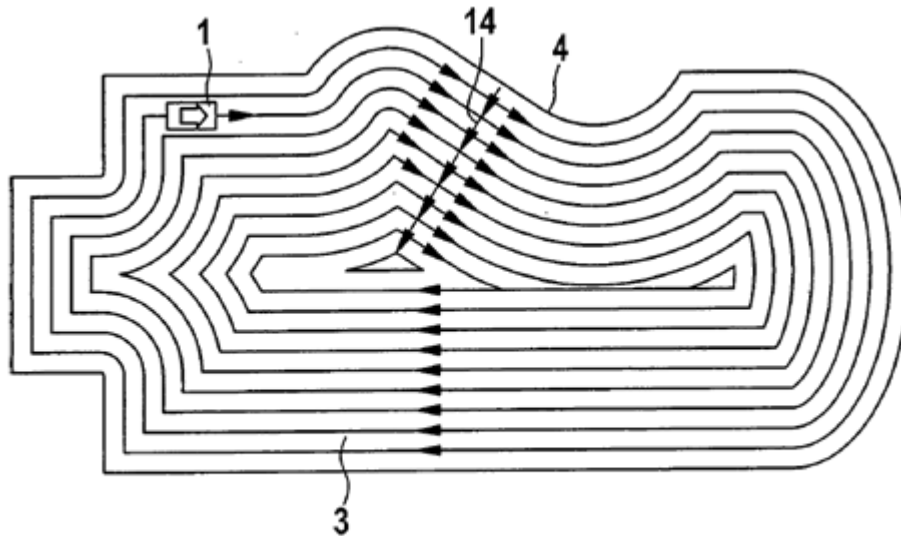


Fig. 2

262. A POSITA would have understood that the trajectory in Figure 2—comprising path segments that follow the contour of boundary line/surface 4 at different offsets—results from control unit 11 repeatedly adjusting drive means 12 based on the measured distance so as to maintain an appropriate spacing from boundary surface 4 while traversing working area 3. Knoll, [0029], FIG. 2. A POSITA also would have understood that, to maintain a desired spacing from the boundary line/surface that delimits working area 3, Knoll's control unit 11 would generate drive-control signals that adjust vehicle motion based on the measured distance—causing the vehicle body to *move away* from the boundary surface (first object) when the measured distance becomes too small (vehicle approaching the

boundary) **and toward** the boundary surface when the measured distance becomes too large (vehicle drifting away). *Id.* In this way, Knoll's control unit 11 is configured to generate, in response to the images captured by camera 6, at least one control signal that causes movement of the body within the swimming pool to, or away from, the first object, where the first object is Knoll's boundary surface 4 / boundary line. A POSITA would have recognized that this "wall-following" or "contouring" behavior relies on a closed-loop feedback mechanism where the error signal (the difference between current distance and target distance) directly drives the steering actuation, allowing corrective movements both "to" and "away from" the boundary to correct for drift and navigation errors.

263. Additionally, Knoll teaches generating control signals to cause movement "away from" a detected obstacle (first object). Knoll, [0015]. Knoll explains that its camera detects obstacles because they "reflect the light beam into the digital camera," and in response, the control unit is configured so that "obstacles are bypassed" or the robot "drive[s] around the obstacle." Knoll, [0015]. A POSITA would have understood that to "bypass" or "drive around" a detected obstacle (first object), the control unit would generate signals causing the vehicle body to move **away** from the obstacle to avoid collision. A POSITA would have understood that the operational command to "bypass" an object located in the robot's current path

would require a vector change in the robot's trajectory that increases the lateral distance between the robot and that object—effectively moving the body "away from" the potential collision point.

4. **Claim 3 (“The pool system of claim 2, wherein the at least one piece of equipment comprises a cleaning device with one or more propulsion mechanisms, the cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation.”)**

264. Claim 3 depends from Claim 2. It is my opinion that Knoll discloses or suggests Claim 3.

265. Knoll’s robotic vehicle 1 constitutes “at least one piece of equipment.” See §VII.D.3.b (2[a]). It is “designed as a pool cleaning vehicle” with “drive means (12) for driving and steering the robotic vehicle (1)” that are “for generating propulsion and for steering.” Knoll, [0027]-[0028], Abstract, Claims 1, 14, FIG. 1.

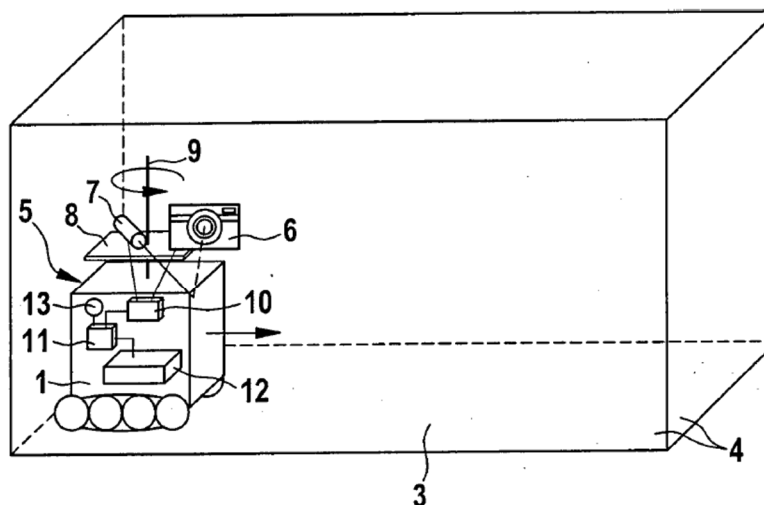


Fig. 1

266. The robotic vehicle includes “suction and/or filter and/or cleaning device” and operates on “working area 3...formed by the bottom of the pool” that is “delimited by four pool walls...forming a circumferential boundary surface 4.” Knoll, [0027]-[0028], FIG. 1. A POSITA would have understood that Knoll’s robotic vehicle comprises a “cleaning device with one or more propulsion mechanisms” because it is a pool cleaning vehicle with integrated suction/filter/cleaning devices and drive means configured for generating propulsion and steering (the propulsion mechanisms). *Id.* A POSITA would have also understood that this cleaning device is “configured to travel adjacent to submerged or water-containing surfaces of the swimming pool” because it operates on the pool bottom and is controlled to maintain a defined distance from the pool walls (traveling adjacent to these surfaces), and these surfaces are submerged when the pool is filled with water (the normal operational environment for pools). *Id.* A POSITA would have further understood that the cleaning device is “configured to...perform a cleaning operation” because the robotic vehicle with its suction/filter/cleaning devices removes debris from pool surfaces as it travels thereon.

267. Therefore, it is my opinion that Knoll renders Claim 3 obvious.

5. Claim 5 (“The pool system of claim 2, wherein the one or more cameras are mounted on the at least one piece of equipment.”)

268. Claim 5 depends from Claim 2. In my opinion, Knoll discloses or suggests Claim 5.

269. Knoll's robotic vehicle 1 is equipped with a **camera 6** that is "arranged on a **mounting plate 8**" attached to the vehicle body. Knoll, [0028], FIG. 1 (annotated below). A POSITA would have understood that because camera 6 is "arranged on a mounting plate 8" attached to the vehicle, the camera is mounted on the vehicle (equipment). *Id.*

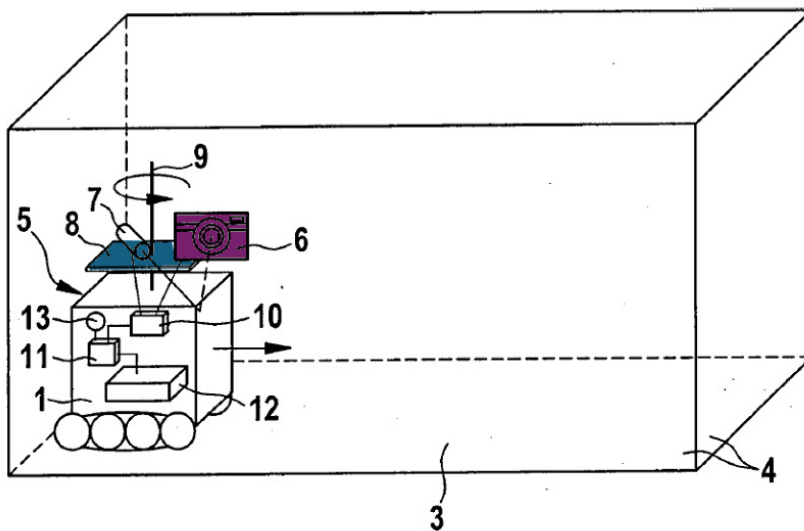


Fig. 1

270. Therefore, it is my opinion that Knoll renders Claim 5 obvious.

6. Claim 6 ("The pool system of claim 2, wherein the one or more cameras are submersible or submerged within the swimming pool or spa.")

271. Claim 6 depends from Claim 2. It is my opinion that Knoll discloses or suggests Claim 6.

272. Camera 6 is mounted on robotic vehicle 1, which operates on “working area 3...formed by the **bottom of the pool.**” Knoll, [0027], FIG.1; *see also* §VII.D.5 (Claim 5). Knoll describes the robotic vehicle as a “pool cleaning robot” whose “working element is, for example, a filter device and/or suction device and/or cleaning device.” Knoll, [0027], [0021]. The pool cleaning vehicle is installed and operates within the swimming pool to clean pool surfaces. *Id.*; *see also* §VII.D.3.b (2[a]).

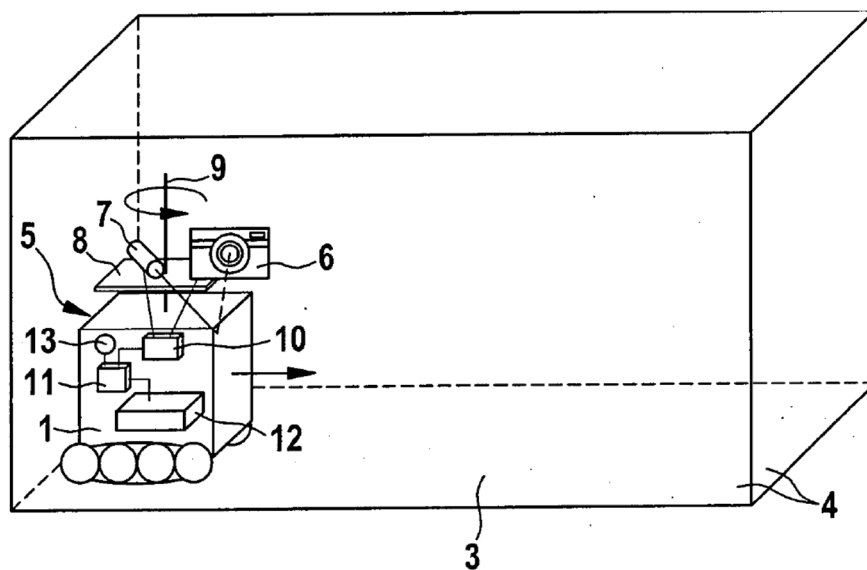


Fig. 1

Knoll, FIG. 1

273. A POSITA would have understood that Knoll’s camera 6 is “submergible or submerged within the swimming pool” because the camera is mounted on robotic vehicle 1, which is submerged in a pool, i.e., during operation

as a pool cleaning robot on the pool bottom when the pool is filled with water (the normal operational environment for pool cleaning devices).

274. Therefore, it is my opinion that Knoll renders Claim 6 obvious.

7. Claim 7 (“The pool system of claim 2, wherein the controller is configured to detect a characteristic of the location based on the visual data and control the piece of equipment based on the detected characteristic.”)

275. Claim 7 depends from Claim 2. In my opinion, Knoll discloses or suggests Claim 7.

276. Knoll describes that control unit 11 (controller) **detects** presence of an obstacle (characteristic) within the working area 3 “formed by the bottom of the pool” (location) based on a captured image (visual data) and **controls** movement of vehicle 1 (equipment) based on the detected characteristic—to bypass the obstacle. Knoll, [0015], [0028]. *See also* §§VII.D.2.e-VII.D.2.g, VII.D.3.c-VII.D.3.e (1[d]-1[e][ii], 2[b]-2[c][ii]).

277. Therefore, it is my opinion that Knoll renders Claim 7 obvious.

8. Claim 12

278. In my opinion, Knoll discloses or suggests Claim 12.

a. 12[pre] “A method for monitoring a pool system, the method comprising”

279. It is my opinion that Knoll discloses or suggests 12[pre].

280. Knoll discloses an autonomous robotic pool cleaning system that uses

a digital camera to detect and measure distance to boundary line/surface and/or obstacles for navigation and control, with a control unit that processes this visual data to control the vehicle's movement within the pool during clean operations. Knoll, Abstract, [0027]-[0028], Claims 1-2, FIGS. 1-2; *see also* §§VII.D.2.g and VII.D.3.d (1[e][ii]&2[c][i]).

281. A POSITA would have understood that Knoll's system performs the claimed method for "monitoring a pool system" because Knoll's system observes and detects physical features of the swimming pool environment—specifically, the pool's boundary surfaces/lines and obstacles—to control the robot's navigation and perform its "pool cleaning" operations. *See, e.g.*, Knoll, [0027]-[0028].

b. 12[a] "receiving images of at least a portion of a location including a swimming pool or spa from one or more cameras"

282. In my opinion, Knoll discloses or suggests 12[a].

283. Knoll's control unit 11 receives visual data (images) of boundary surfaces/lines and/or obstacles from digital camera 6 through evaluation unit 10. *See* Knoll, [0028], FIG. 1; *see also* §VII.D.3.d (2[c][i]). A POSITA would have understood that these are "images of at least a portion of a location including a swimming pool" because the camera observes and captures images of the boundary line/surface (measurement object) of the working area or obstacles within the pool.

Knoll, [0018], [0027]-[0028], FIG. 1; *see also* §VII.D.3.c (element 2[b]).

c. 12[b] “determining a target area and detecting a characteristic of the target area based on the images; and”

284. In my opinion, Knoll discloses or suggests 12[b].

285. Knoll’s control unit 11 receives images from camera 6, detects presence of an obstacle (characteristic) in an area within working area 3 based on the images, and based on this detected obstacle presence, controls vehicle 1 to bypass or “drive around the obstacle at a constant distance” in that specific area. Knoll, [0015]; *see also* §§VII.D.2.e-VII.D.2.g, VII.D.3.c-VII.D.3.e, VII.D.7 (1[d]-1[e][ii], 2[b]-2[c][ii], Claim 7). Because the system’s control action (bypassing motion) is applied to the specific area in response to the obstacle detected in that same area, a POSITA would have understood or found it obvious that the area sensed by Knoll’s system and that contains the obstacle is determined as a “target area,” at least because it was the area being sensed by the sensor 6 and measurement light source 7 for purposes of, among other things, detecting the presence of an obstacle. Furthermore, a POSITA would have understood that in the context of a robotic monitoring system, the “target area” is functionally defined as the area currently being sensed by the camera. By orienting the camera and capturing an image frame, the system effectively determines a specific portion of the pool environment as the target for

inspection. Consequently, when the robot detects a feature (e.g., an obstacle) within that field of view, it is detecting a characteristic of that determined “target area.” Once this characteristic is detected in the target area, the subsequent claim limitations (e.g., generating the control response) are triggered to act upon that area.

d. 12[c] “generating a control response based on the detected characteristic of the target area.”

286. In my opinion, Knoll discloses or suggests 12[c].

287. Knoll’s control unit 11 detects obstacle presence (characteristic) and generates control signals that control the drive means 12 (part of vehicle 1) to move and steer vehicle 1 to bypass or “drive around the obstacle at a constant distance.” Knoll, [0015], [0028]; *see also* §§VII.D.3.e&VII.D.7 (element 2[c][ii], Claim 7). A POSITA would have understood that Knoll’s control signals to control vehicle 1 constitute “a control response” generated “based on the detected characteristic” (obstacle presence) of the target area (the area where the obstacle is located). A POSITA would have understood that the generation of this control response is linked to the characteristic detected within that specific target area. Because the system identifies the obstacle within the sensed field of view (the target area), the resulting steering command (the control response) is calculated specifically to address that detected condition—i.e., to modify the vehicle's trajectory relative to that specific location. Had the characteristic of that target area been different (e.g., obstacle-free),

the control response would have been different (e.g., continued straight movement), confirming to a POSITA that the response is generated based on the characteristic of that target area.

9. Claim 14 (“The method of claim 12, wherein generating the control response comprises controlling an operation of a piece of equipment of the swimming pool or spa.”)

288. Claim 14 depends from Claim 12. It is my opinion that Knoll discloses or suggests Claim 14.

289. Knoll’s robotic vehicle 1 is a “piece of equipment” for the swimming pool. *See also* §VII.D.3.b (2[a]). Additionally, Knoll’s control unit 11 generates the control response by controlling the operation of drive means 12 (part of robotic vehicle 1) to move or steer robotic vehicle 1 based on the detected presence of an obstacle (characteristic) within the working area 3. Knoll, [0015], [0028], FIG. 1; *see also* §§VII.D.3.e, VII.D.8.d (2[c][ii], 12[c]).

290. Therefore, it is my opinion that Knoll renders Claim 14 obvious.

10. Claim 19

291. Claim 19 depends from Claim 12. In my opinion, Knoll discloses or suggests Claim 19.

a. 19[a] (“The method of claim 12, wherein generating the control response comprises controlling operation of a cleaning device configured to travel adjacent to submerged or water-containing surfaces of the

swimming pool or spa and to perform a cleaning operation”)

292. It is my opinion that Knoll discloses or suggests 19[a].

293. Knoll’s control unit 11 generates the control response by controlling drive means 12, which move and steer robotic vehicle 1 (cleaning device). Knoll, [0028], [0011]; *see also* §§VII.D.3.e, VII.D.8.d, VII.D.9 (2[c][ii], 12[c], Claim 14).

294. Knoll’s robotic vehicle 1 is a cleaning device with propulsion mechanisms (drive means) configured to operate on the pool bottom and maintain a distance from the boundary surface 4 (and boundary lines) formed by or on pool walls (travel adjacent to submerged or water-containing surfaces of the swimming pool), and to remove debris from pool surfaces with its suction/filter/cleaning devices (perform a cleaning operation). *See also* Knoll, [0007], [0011], [0015], [0021], [0027]-[0028], FIGS. 1-2; *see also* §VII.D.4 (Claim 3).

b. 19[b] (“wherein controlling operation of the cleaning device comprises one or more of controlling a path or route of the cleaning device, an aggressiveness of cleaning chemicals deployed, an aggressiveness of mechanical cleaning, or a speed of the cleaning device.”)

295. It is my opinion that Knoll discloses or suggests 19[b].

296. Knoll’s control unit 11 controls drive means 12 to move and steer vehicle 1 based on detected presence of an obstacle. Knoll, [0015], [0028]; *see also*

§VII.D.8.d, VII.D.9 (12[c], Claim 14). Specifically, Knoll teaches causing vehicle 1 to bypass or “drive around the obstacle at a constant distance,” which constitutes controlling the path or route of the cleaning device. Knoll, [0015].

297. Therefore, it is my opinion that Knoll renders Claim 19 obvious.

E. Ground 2B: Claims 7, 8, 12-14, and 19 are Unpatentable over Knoll and Fu-007

298. In my opinion, Claims 7, 8, 12-14, and 19 are unpatentable over Knoll and Fu-007.

1. Reasons for Combining Knoll and Fu-007

299. Both Knoll and Fu-007 disclose autonomous underwater pool cleaning robots using cameras and controllers to perform cleaning operations. Knoll describes an “autonomous robotic vehicle 1 designed as a pool cleaning vehicle” with a digital camera 6 and control unit 11 that processes camera images to control drive means 12 for navigation. Knoll, Abstract, [0027]-[0028], FIG. 1. Fu-007 similarly describes an “underwater cleaning robot” with “monitoring camera 2” and a central processing unit that processes camera images to control cleaning drive wheels. Fu-007, Abstract, pp.8-9, 12-14, Claim 4, FIG. 6. A POSITA would have been motivated to combine the complementary teachings of Knoll and Fu-007 to achieve improved autonomous pool cleaning systems.

300. A POSITA would have recognized that the teachings in Knoll and Fu-

007 are directed to the same pool cleaning technical field, address similar technical challenges in autonomous pool cleaning, and provide complementary technical solutions. Specifically, both references use a controller to process captured images and generate control signals to cause movement of the pool cleaning robot within the swimming pool. Knoll discloses that “control unit 11” processes images from “digital camera 6” and “controls the drive means 12” to move “robotic vehicle 1.” Knoll, [0028], FIG. 1. *See also, id.*, [0015]. Fu-007 similarly discloses that its “central processing unit” processes images from “monitoring camera 2” and controls “cleaning drive wheels 3” to move the robot. Fu-007, pp.10, 12-16, Claims 4, 7, FIG. 6.

301. Additionally, both references teach motorized drive mechanisms to cause and control movement of the pool cleaner during operation. Knoll discloses “drive means (12) for driving and steering the robotic vehicle (1) on a working area (3).” Knoll, Abstract, Claim 1; *see also, id.*, [0028]. Fu-007 discloses “four independently driven” “cleaning drive wheels 3” that “implement tasks of the robot including moving forward, moving backward, turning, and scrubbing for cleaning through different wheel speed combinations.” Fu-007, pp.8-10, 12-16, Claims 1, 3-4.

302. Accordingly, a POSITA would have investigated the technical

teachings in both Knoll and Fu-007 to seek guidance when designing a pool cleaning system.

303. Knoll uses camera-based distance measurement for navigation and obstacle avoidance. Knoll explains that “the distance-determining device uses the rotating light beam source and the rotating camera to determine the distance to the boundary line or boundary surface by triangulation.” Knoll, [0018]. Knoll further explains that “[t]he distance-determining device can be used to detect obstacles, because the obstacles reflect the light beam into the digital camera. Thus, if the control unit is designed accordingly, it is possible to drive around the obstacle at a constant distance.” Knoll, [0015].

304. Fu-007 employs threshold-based cleanliness control. Specifically, Fu-007 teaches that “[d]uring autonomous cleaning, a swimming pool cleanliness image threshold is set, the robot uses the monitoring camera 2 to take image(s) of the bottom of the swimming pool, determines a cleanliness level of the bottom of the swimming pool by comparing the image(s) with the threshold, and plans a cleaning movement, and then adjusts operating conditions of the four cleaning drive wheels 3 and the drainage device to complete the cleaning task.” Fu-007, pp.10, 14-16, Claim 7.

305. In my opinion, these represent complementary approaches—Knoll

providing navigation control and Fu-007 providing cleaning intensity control—that a POSITA would have combined.

306. Knoll's camera 6 acquires images of boundary line/surface 4 for distance measurement. Knoll explains that "a minimum distance to the boundary surface 4 is determined for each rotation of the mounting plate 8 comprising the digital camera 6 and light beam source 7." Knoll, [0028]; *see also* Knoll, [0015], [0018], FIG. 1.

307. A POSITA would have recognized that images captured by Knoll's camera contain visual information about pool surfaces—not merely distance data. Knoll's digital camera 6, like any digital camera, captures a complete image of the scene it views. Although Knoll processes these images to extract distance information, the underlying image data necessarily includes visual information about the appearance of pool surfaces, including the presence or absence of debris.

308. A POSITA seeking to improve Knoll's cleaning effectiveness would have been motivated to add Fu-007's cleanliness detection and threshold-based control functionalities, thereby enabling Knoll's control unit 11 to adjust cleaning operations based on actual surface conditions in addition to navigation control for the following reasons.

309. First, this modification would have advanced Knoll's stated goal to

achieve “complete and efficient cleaning of a pool floor and/or the pool walls.” Knoll, [0007]. A POSITA would have recognized that with Fu-007’s cleanliness-based control, Knoll’s system would apply more aggressive cleaning to dirtier areas and lighter cleaning to cleaner areas, thereby improving cleaning effectiveness by adapting operations based on actual surface conditions.

310. Second, a POSITA would have been motivated to make such modification to provide energy conservation and economical efficiency benefits to Knoll’s robotic vehicle. Fu-007 teaches that its system achieves “energy conservation, economical efficiency” by adjusting operating conditions based on detected cleanliness. Fu-007, Abstract, p.11. This modification would also extend operational run-time and reduce wear on mechanical components.

311. A POSITA would have had a reasonable expectation of success in making these modifications because both references employ similar camera-based systems in the same operational environment (underwater pool cleaning).

312. Specifically, both Knoll and Fu-007 employ a common system architecture comprising three functional layers:

313. (1) Image acquisition layer. Knoll discloses “digital camera 6” that captures images of “boundary surface 4.” Knoll, [0015], [0028], FIG. 1. Fu-007 discloses “monitoring camera 2” that captures images of “the bottom of the

swimming pool.” Fu-007, pp.8-10, 14-16, Claim 7.

314. (2) Image processing layer. Knoll discloses “control unit 11” that processes images from camera 6 to determine distance values. Knoll, [0028]. Fu-007 discloses a “central processing unit” that processes images from camera 2 by “comparing the image(s) with the threshold” to determine “a cleanliness level” and control cleaner operation Fu-007, pp. 9-10, 14-16, Claim 7, FIG. 6.

315. (3) Motor control layer. Knoll discloses “drive means 12” that are controlled by control unit 11 based on the processing results. Knoll, [0028]. Fu-007 discloses “cleaning drive wheels 3” that are controlled by the central processing unit to “adjust[] operating conditions” based on the cleanliness determination. Fu-007, pp. 14-16, Claim 7, FIG. 6.

316. This architectural similarity means that integrating Fu-007’s teachings into Knoll’s system would not require fundamental redesign of Knoll’s hardware or control architecture. The modification would involve adding threshold comparison logic to Knoll’s existing control unit 11 to analyze the images already captured by camera 6 for cleanliness characteristics. This is a routine software modification that would have been within ordinary skill in the art.

317. A POSITA implementing Fu-007’s known threshold-based cleanliness control technique in Knoll’s system would have had a predictable result: a pool

cleaning robot capable of adjusting cleaning operations based on both navigation requirements (per Knoll) and detected pool surface cleanliness (per Fu-007).

2. Claim 7

318. Claim 7 depends from Claim 2. Alternative to § VII.D.7, it is my opinion that the Knoll-Fu-007 combination discloses or suggests Claim 7.

319. Knoll discloses control unit 11 (controller) that processes visual data from camera 6. Knoll, [0028], [0018], FIG. 1; *see also* §§VII.D.2.f-VII.D.2.g (Knoll, 1[e][i]-[ii]).

320. Fu-007 teaches using “monitoring camera 2” to capture images of pool surfaces and determining “a cleanliness level of the bottom of the swimming pool” (characteristic of the location) “by comparing the image(s)” to “a swimming pool cleanliness image threshold.” Fu-007, pp.10, 14-16, Claim 7, FIG. 6; *see also* §VII.B.1 (Cui-Fu-007, 8[b]).

321. As explained in §VII.B.2, with a reasonable expectation of success, a POSITA would have been motivated to combine the teachings of Knoll and Fu. In the combined system, Knoll’s robotic vehicle 1 would operate with control unit 11 processing images from camera 6 for dual purposes: (1) distance measurement via triangulation for navigation (as Knoll teaches), and (2) cleanliness detection via threshold comparison (as Fu-007 teaches). Knoll, [0015], [0018], [0028]; Fu-007,

pp.10, 14-16, Claim 7. Control unit 11 would determine the robot's position relative to boundary line/surface 4 (using Knoll's triangulation method) and simultaneously determine cleanliness levels of pool surfaces in the captured images (using Fu-007's threshold comparison method). *Id.* Based on detected cleanliness levels (characteristic) of pool surfaces (location), control unit 11 (controller) would control operating conditions of drive means 12 of vehicle 1 (equipment), implementing Fu-007's teaching of varying "rotational speed of each wheel" and adjusting cleaning intensity based on pool surface cleanliness. Fu-007, pp.14-16; Knoll, [0028]. Areas with higher debris levels would receive more aggressive cleaning, while already-clean areas would receive lighter treatment, thereby improving operational efficiency while maintaining Knoll's complete area coverage. *Id.*

322. As explained in §VII.E.1, a POSITA would have reasonably expected success in combining Knoll with Fu-007 because applying Fu-007's well-known control logic to Knoll's existing and suitable hardware to achieve a predictable result because this would be a routine software programming modification to Knoll's existing controller.

323. Therefore, it is my opinion that Knoll and Fu-007 render Claim 7 obvious.

3. Claim 8

324. Claim 8 depends from Claim 7. In my opinion, Knoll-Fu-007 combination discloses or suggests Claim 8.

a. 8[a] “The pool system of claim 7, wherein the characteristic comprises a cleanliness of a surface of the swimming pool, and”

325. The Knoll-Fu-007 combination discloses or suggests 8[a]. Specifically, as explained in §VII.E.1 (Knoll-Fu-007, claim 7), the Knoll-Fu-007 combination would detect a cleanliness (characteristic) of “the bottom of the swimming pool.” Fu-007, pp.10, 14-16, Claim 7; *see also* §VII.B.3.b (Cui-Fu-007, 8[b]).

b. 8[b] “wherein the controller is configured to control the piece of equipment based on the detected cleanliness being outside of a threshold.”

326. In my opinion, the Knoll-Fu-007 combination discloses or suggests 8[b].

327. Fu-007 teaches using “monitoring camera 2” to capture images of pool surfaces and determining “a cleanliness level of the bottom of the swimming pool” (characteristic of the location) “by comparing the image(s)” to “a swimming pool cleanliness image threshold.” Fu-007, pp.10, 14-16, Claim 7; *see also* §VII.B.3.b Cui-Fu-007, 8[b]).

328. As explained above in §VII.E.1-VII.E.2VII.E.1 (Knoll-Fu-007, Claim 7), with a reasonable expectation of success, a POSITA would have been motivated

to add Fu-007’s functionalities into Knoll’s controller 11, allowing the modified controller 11 to be configured to control operating conditions of drive means 12 of vehicle 1 (equipment) to vary “rotational speed of each wheel” and adjust cleaning intensity based on the detected cleanliness being outside of the “cleanliness image threshold.” Fu-007, pp.10, 12-16; Knoll, [0028].

329. Therefore, it is my opinion that Knoll and Fu-007 render Claim 8 obvious.

4. Claim 12

330. In my opinion, the Knoll-Fu-007 combination discloses or suggests Claim 12. As explained in §VII.E.1, a POSITA would have been motivated to combine Knoll and Fu-007, with a reasonable expectation of success.

a. 12[pre] “A method for monitoring a pool system, the method comprising:”

331. It is my opinion that Knoll discloses or suggests 12[pre]. *See* §VII.D.8.a (Knoll, 12[pre]).

b. 12[a] “receiving images of at least a portion of a location including a swimming pool or spa from one or more cameras;”

332. In my opinion, Knoll discloses or suggests 12[a]. *See* §VII.D.8.b (Knoll, 12[a]).

c. 12[b] “determining a target area and detecting a characteristic of the target area based on the images; and”

333. It is my opinion that the Knoll-Fu-007 combination discloses or suggests 12[b].

334. As explained in §§VII.E.1-VII.E.3 (Reasons for combining Knoll and Fu-007, Claims 7-8), the Knoll-Fu-007 combination’s control unit 11 receives images from camera 6, detects cleanliness levels (characteristic) of pool surface areas based on the images by comparing them to a threshold, and based on this detected cleanliness, controls drive means 12 to adjust cleaning intensity (e.g., motor speed) in the specific areas. Fu-007, pp.10, 12-16; Knoll, [0028]. Because the combined system’s control action (adjusting cleaning intensity through wheel speed variations) is applied to a specific area in response to the cleanliness characteristic detected in that area, a POSITA would have understood or found it obvious that the area sensed by the combined system and that contains the debris is determined as a “target area,” at least because it was the area being sensed by the camera for purposes of, among other things, detecting cleanliness levels. Furthermore, a POSITA would have understood that in the context of such a robotic scanning system, the "target area" is functionally defined as the area currently being sensed by the camera. By orienting the camera and capturing an image frame, the system effectively

determines a specific portion of the pool environment as the target for inspection. Consequently, when the robot detects a feature (e.g., the cleanliness or sediment levels taught by Fu-007) within that field of view, it is detecting a characteristic of that determined “target area.” Once this characteristic is detected in the target area, the subsequent claim limitations (e.g., generating the control response) are triggered to act upon that area.

d. 12[c] “generating a control response based on the detected characteristic of the target area.”

335. In my opinion, the Knoll-Fu-007 discloses or suggests 12[c].

336. As explained in §§VII.E.1-VII.E.3 (Reasons for combining Knoll and Fu-007, Claims 7-8), the Knoll-Fu-007 combination’s control unit 11 detects cleanliness levels (characteristic) and generates control signals that control drive means 12 (part of vehicle 1) of vehicle 1 to adjust wheel speeds and cleaning intensity based on detected cleanliness levels. Fu-007, pp.10, 12-16, Claim 7; Knoll, [0028]. A POSITA would have understood that the Knoll-Fu-007 combination’s control signals that control drive means 12 of vehicle 1 are “a control response” generated “based on the detected characteristic” (cleanliness level) of the target area (the determined specific pool surface area where the cleanliness is detected). A POSITA would have further understood that the generation of this control response is directly causally linked to the characteristic detected within that specific target

area. Because the system identifies the cleanliness level within the sensed field of view (the target area), the resulting speed adjustment command (the control response) is calculated specifically to address that detected condition—i.e., to modify the cleaning intensity applied to that specific location. Had the characteristic of that target area been different (e.g., already clean with no sediment), the control response would have been different (e.g., maintaining standard speed), confirming to a POSITA that the response is generated based on the characteristic of that target area.

337. Therefore, it is my opinion that Knoll and Fu-007 render Claim 12 obvious.

5. Claim 13

338. Claim 13 depends from Claim 12. It is my opinion that the Knoll-Fu-007 combination discloses or suggests Claim 13. As explained in §VII.E.1, a POSITA would have been motivated to combine Knoll and Fu-007, with a reasonable expectation of success.

a. 13[a] “The method of claim 12, wherein the target area comprises a portion of a surface of the swimming pool or spa, and”

339. As explained above in §VII.E.4.c (12[b]), the Knoll-Fu-007 combination teaches or suggests determining a target area of the pool for sensing of

cleanliness of “the **bottom** of the swimming pool.” Fu-007, pp.10, 14-16, Claim 7; *see also* §§VII.E.2-VII.E.3 (Claims 7-8). Hence, Knoll-Fu-007 combination teaches or suggests the target area comprises a portion of a surface (bottom) of the swimming pool.

b. 13[b] “wherein the characteristic comprises a cleanliness characteristic of the portion of the surface of the swimming pool or spa.”

340. In my opinion, the Knoll-Fu-007 combination discloses or suggests 13[b], because as explained in §VII.E.4.c (12[b]), the Knoll-Fu-007 combination detects a cleanliness level (characteristic) of the bottom (portion of the surface) of the swimming pool. Fu-007, pp.10, 14-16, Claim 7; *see also* §§VII.E.2-VII.E.3 (Claims 7-8).

341. Therefore, it is my opinion that Knoll and Fu-007 render Claim 13 obvious.

6. Claim 14

342. Claim 14 depends from Claim 12. It is my opinion that the Knoll-Fu-007 combination discloses or suggests Claim 14. As explained in §VII.E.1, a POSITA would have been motivated to combine Knoll and Fu-007, with a reasonable expectation of success. Specifically, in my opinion, Knoll’s robotic vehicle 1 constitutes the “piece of equipment” for the swimming pool. *see also*

§VII.D.3.b (2[a]). Further, as explained in §VII.E.1, it is my opinion that a POSITA would have been motivated to add Fu-007’s functionalities to Knoll’s control unit 11 to Fu-007 generates a control response that controls the operation of drive means 12 (part of robotic vehicle 1) to move or steer robotic vehicle 1 based on the detected cleanliness levels. Fu-007, pp.10, 12-16, Claim 7; Knoll, [0028]; *see also* §VII.E.4.d (12[c]).

343. Therefore, it is my opinion that Knoll and Fu-007 render Claim 14 obvious.

7. Claim 19

344. Claim 19 depends from Claim 12. In my opinion, the Knoll-Fu-007 combination discloses or suggests Claim 19. As explained in §VII.E.1, a POSITA would have been motivated to combine Knoll and Fu-007, with a reasonable expectation of success.

- a. **19[a] “The method of claim 12, wherein generating the control response comprises controlling operation of a cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation,”**

345. The Knoll-Fu-007 combination discloses or suggests 19[a].

346. As explained above, the Knoll-Fu-007 combination’s control unit 11 generates the control response by controlling the drive means 12, which move and

steer robotic vehicle 1 (cleaning device), which is “a cleaning device configured to travel adjacent to submerged or water-containing surfaces of the swimming pool or spa and to perform a cleaning operation.” Fu-007, pp.10, 12-16, Claim 7; Knoll, [0028]; *see also* §§VII.E.4.d, VII.E.6 (Knoll-Fu-007, 12[c], Claim 14); §§VII.D.4, VII.D.10.b (Knoll, Claim 3, 19[b]).

- b. 19[b] “wherein controlling operation of the cleaning device comprises one or more of controlling a path or route of the cleaning device, an aggressiveness of cleaning chemicals deployed, an aggressiveness of mechanical cleaning, or a speed of the cleaning device.”**

347. It is my opinion that the Knoll-Fu-007 combination discloses or suggests 19[b].

348. As explained above, the Knoll-Fu-007 combination’s control unit 11 controls drive means 12 to adjust wheel speeds and cleaning intensity of robotic vehicle 1 based on detected cleanliness levels. Fu-007, pp.10, 12-16, Claim 7; Knoll, [0028]; *see also* §§VII.E.4.d, VII.E.6 (Knoll-Fu-007, 12[c], Claim 14). Specifically, Fu-007 teaches that “the rotational speed of each wheel 3 is adjustable” and “[t]hrough different wheel speed combinations, cleaning actions with different cleaning intensities can be implemented,” thereby varying mechanical cleaning force based on detected surface conditions. Fu-007, pp.10, 14-16, Claim 7. This constitutes controlling both the speed of the cleaning device (through adjustable

wheel speeds) and the aggressiveness of mechanical cleaning (through variable cleaning intensities).

349. Therefore, it is my opinion that Knoll and Fu-007 render Claim 19 obvious.

F. Ground 2C: Claims 10 and 17 are Unpatentable over Knoll, Fu-007, and Hsu

1. Reasons for Combining Knoll, Fu-007, and Hsu

350. Knoll, Fu-007, and Hsu all disclose autonomous cleaning robots using cameras and controllers to perform cleaning operations with user monitoring and control capabilities.

351. As explained in §VII.E.1 (Knoll-Fu-007 Motivation), the Knoll-Fu-007 combination provides a pool cleaning robot with camera-based navigation (Knoll) and wireless communication capability (Fu-007). Specifically, Knoll discloses “an autonomous robotic vehicle 1 designed as a pool cleaning vehicle” with digital camera 6 and control unit 11 that processes camera images to control drive means 12 for navigation. Knoll, [0027]-[0028], FIG. 1. Fu-007 discloses wireless communication via “control signal buoyant antenna 27” that “floats on a water surface to wirelessly communicate with the control keyboard 31.” Fu-007, pp.8-9, 12-14, Claim 4, FIG. 8. Fu-007 further teaches that “a control signal is sent by manual operation using the control keyboard, to directly or indirectly control the

underwater cleaning robot.” Fu-007, pp.9-10, 14, Claim 5.

352. As explained in §VII.C.1 (Hsu Summary), Hsu discloses a cleaning robot with an environment information detection device 10 that can be “a camera, a video camera,” and a map construction module 20 that constructs an environment map “based on the environment information detected by the environment information detection device.” Hsu, Abstract, [0017]-[0018], [0037]-[0038], Claim 1, FIGS. 1, 5. Hsu teaches that the environment map is “updated dynamically” based on “real-time working environment information detected by the environment information detection device 10.” Hsu, [0020], [0033]-[0034], Claims 3, 6, 8-9, 12, 15-16, FIG. 5. Hsu further teaches that the “environment map 120 can be transmitted to the display screen on an external electronic device 130 or an electronic device 130a by...autonomous robot 1 via a communication platform 110.” Hsu, [0021],[0028], Claim 7, FIGS. 4-5. Notably, Hsu teaches that users can interact with this remote display: “users can set a working boundary for the autonomous robot 1 on the display screen on the electronic device 130 or electronic device 130a” and “the autonomous robot 1 of the present invention can be controlled remotely such that users can assign a working zone for the autonomous robot 1 or control the autonomous robot 1 through the electronic device 130 or electronic device 130a via the communication platform 110.” Hsu, [0021].

353. A POSITA would have been motivated to combine the complementary teachings of Knoll-Fu-007 and Hsu to achieve improved visual monitoring and user control of autonomous pool cleaning operations for the following reasons.

354. First, a POSITA would have been motivated to add Hsu's remote map display and user control functionality to the Knoll-Fu-007 combination to advance Knoll's stated goal of achieving "complete and efficient cleaning."

355. Knoll expressly states that its invention "allows for a complete and efficient coverage of the working area, in particular a complete and efficient cleaning of a pool floor and/or the pool walls." Knoll, [0007]. Knoll further explains that "the working area can be optimized and/or completely covered by processing the distance information without having to define a route beforehand." *Id.*

356. Hsu teaches that environment map 120 shows the working environment including working zones and robot position, and can be transmitted to external devices for remote viewing. Hsu, [0018]-[0022], FIG. 2. Hsu explains that the map is "updated dynamically" during operation, which "increase[s] the accuracy of the environment map." Hsu, [0020], [0033]-[0034], Claims 3, 6, 8-9, 12, 15-16, FIG. 5.

357. A POSITA would have recognized that adding Hsu's remote map display to the Knoll-Fu-007 combination would enable users to verify that Knoll's "complete" coverage is being achieved by visually monitoring the robot's location

and progress on an external device. This visual verification would complement Knoll's autonomous coverage algorithm by allowing users to confirm that no areas were missed.

358. Second, a POSITA would have been motivated to add Hsu's teachings to the Knoll-Fu-007 combination to provide users with remote monitoring and control capabilities without requiring the user to stand by the pool during the cleaning operation.

359. Hsu teaches that the environment map "can be transmitted to the display screen on an external electronic device 130 or an electronic device 130a," where device 130 is a PDA and device 130a is a personal computer. Hsu, [0021], FIG. 4. Hsu further teaches that this remote interface enables interactive control: "users can set a working boundary for the autonomous robot 1 on the display screen on the electronic device 130 or electronic device 130a" and "the autonomous robot 1 of the present invention can be controlled remotely such that users can assign a working zone for the autonomous robot 1 or control the autonomous robot 1 through the electronic device 130 or electronic device 130a via the communication platform 110." Hsu, [0021].

360. Fu-007 similarly teaches remote user control capability. Fu-007 discloses that "a control signal is sent by manual operation using the control

keyboard, to directly or indirectly control the underwater cleaning robot via the control signal buoyant antenna.” Fu-007, pp.10, 14, Claim 5. Fu-007 explains that “[i]n the manual mode, a control signal is sent by manual operation using the control keyboard, to directly or indirectly control the underwater cleaning robot via the control signal buoyant antenna.” Fu-007, pp.9-10, 14, Claim 5.

361. A POSITA would have recognized that combining Hsu’s graphical map display and remote control functionality with Fu-007’s wireless communication capability would allow users to both monitor cleaning progress and send control commands from a remote device such as a PDA or personal computer. This would provide significant practical benefits—users could monitor and control the pool cleaning operation from inside their home rather than standing by the pool for the duration of the cleaning cycle.

362. A POSITA would have had a reasonable expectation of success in combining the Knoll-Fu-007 combination with Hsu’s teachings.

363. First, the Knoll-Fu-007 combination already has the necessary hardware components for implementing Hsu’s remote display and control functionality:

364. (1) Image acquisition layer. Knoll discloses “digital camera 6” that captures images of “boundary surface 4.” Knoll, [0015], [0028], FIG. 1. Fu-007

discloses “monitoring camera 2” that captures images of “the bottom of the swimming pool.” Fu-007, pp.8-10, 14-16, Claim 7. *See also* §§VII.B.1 (Fu-007 summary), VII.D.1 (Knoll summary).

365. (2) Image processing layer. Knoll discloses “control unit 11” that processes images from camera 6 to determine distance values and control robot movement. Knoll, [0028]. Fu-007 discloses a “central processing unit” that processes images from camera 2 by “comparing the image(s) with the threshold” to determine “a cleanliness level” and control cleaner operation. Fu-007, pp. 9-10, 14-16, Claim 7, FIG. 6. *See also* §§VII.B.1 (Fu-007 summary), VII.D.1 (Knoll summary).

366. (3) Wireless communication. Fu-007 discloses control signal buoyant antenna 27 that enables wireless communication between the underwater robot and external devices. Fu-007, pp.8-10, 12-16, Claims 4-5, 7, FIG. 8.

367. (4) User control interface. Fu-007 discloses control keyboard 31 for sending control signals to the robot. Fu-007, pp.8-10, 12-14, Claims 4-5.

368. Second, the modification required to implement Hsu’s map construction and remote display functionality would involve software changes to Knoll’s control unit 11. Specifically, control unit 11 would be programmed to: (a) construct a graphical map based on images captured by camera 6; (b) update the map

dynamically during cleaning operations; and (c) transmit the map via Fu-007's wireless communication system to external devices for display. These are routine software programming tasks that would have been within ordinary skill in the art.

369. Third, implementing Hsu's interactive user control functionality would similarly involve software modifications to enable control unit 11 to receive user commands transmitted from external devices via the wireless communication system and adjust robot operation accordingly. Fu-007 already demonstrates that such bidirectional wireless communication for robot control was achievable in underwater pool cleaning applications.

370. For these reasons, it is my opinion that a POSITA would have had a reasonable expectation of success in combining the teachings of Knoll, Fu-007, and Hsu.

2. Claim 10

371. Claim 10 depends from Claim 2. It is my opinion that the combination of Knoll, Fu-007, and Hsu discloses or suggests Claim 10.

372. Knoll teaches control unit 11 (controller) that receives images (visual data) from camera 6. Knoll, [0018], [0028], FIG. 1. Control unit 11 processes images from camera 6 for distance measurement, obstacle detection, and navigation control. Knoll, [0015], [0018], [0028], FIG. 1; *see also* §§VII.D.2.f-VII.D.2.g, VII.D.3.d-

VII.D.3.e (1[e][i]-1[e][ii], 2[c][i]-2[c][ii]).

373. As explained in §VII.B.1 (Fu-007 summary), Fu-007 teaches wireless communication via control signal buoyant antenna 27 that “floats on a water surface to wirelessly communicate.” Fu-007, pp.9-10, 14, Claim 4, FIG. 8.

374. As explained in §VII.C.1 (Hsu summary), Hsu teaches that when the environment information detection device is a camera, “an environment map is constructed based on the environment information detected,” “updated dynamically...based on the real-time working environment information detected by the environment information detection device 10,” and “can be transmitted to the display screen on an external electronic device 130 or an electronic device 130a,” where device 130 is a PDA and device 130a is a personal computer. Hsu, Abstract, [0018]-[0021], [0024], [0033]-[0034], [0037]-[0038], Claims 3, 6-9, 12, 15-16, FIGS. 1-5. Hsu teaches that the dynamically updated map reflects “real-time working environment information” including detected obstacles. Hsu, [0020].

375. As explained in §VII.F.1, a POSITA would have been motivated to combine Knoll, Fu-007, and Hsu with a reasonable expectation of success. In the combined system, Knoll’s control unit 11 would receive images from camera 6 (visual data), construct a graphical map (graphical depiction; per Hsu) showing working area 3, boundary surface 4, robot position, and detected obstacles based on

the camera images, and transmit this graphical map via Fu-007's wireless communication system to external electronic device 130 or 130a (remote device; per Hsu) for display. Knoll, [0015], [0018], [0028]; Hsu, [0018]-[0021], [0037]-[0038], Claims 7, 16, FIGS. 1-4; Fu-007, pp.9-10, 14, Claim 4, FIG. 8. The map would be updated dynamically as robot 1 moves and camera 6 captures images during cleaning operations. Hsu, [0020], [0033]-[0034], Claims 3, 6, 8-9, 12, 15-16.

376. Hsu's external electronic devices 130/130a are separate devices that communicate with the robot via communication platform 110. Hsu, [0021], FIG. 4. A POSITA would have understood that these external devices constitute "remote device" as recited in Claim 10 because they are physically separate from the robot and receive transmitted data wirelessly. *See also* §VII.C.3 (Cui-Hsu, Claim 10). A POSITA would have understood that presenting the graphical map on the remote device display constitutes "the control action" based on visual data from camera 6, as expressly recited in Claim 10.

377. As explained in §VII.F.1, a POSITA would have reasonably expected success in making such modification.

378. Therefore, it is my opinion that the Knoll-Fu-007-Hsu combination renders Claim 10 obvious.

3. Claim 17

379. Claim 17 depends from Claim 12. It is my opinion that the Knoll-Hsu combination discloses or suggests Claim 17.

a. 17[a] “The method of claim 12, wherein generating the control response comprises prompting a user on a remote device, and”

380. In my opinion, the Knoll-Fu-007-Hsu combination discloses or suggests 17[a].

381. As explained in §VII.F.2 (Claim 10), the combined system displays a dynamically updated map of the working area on an external electronic device (remote device). Specifically, Knoll’s control unit 11 would construct a graphical map showing working area 3, boundary surface 4, robot position, and detected obstacles based on images from camera 6, and transmit this map via Fu-007’s wireless communication system to Hsu’s external electronic device 130 or 130a for display.

382. Hsu teaches that this remote interface is not merely a passive display; it provides interactive functionality that allows users to actively control the robot. Specifically, Hsu teaches that “an input device 90 can be used by a user to assign a working boundary 140 on the environment map 120 on the display interface 70.” Hsu, [0019]. Hsu further teaches that “users can set a working boundary for the autonomous robot 1 on the display screen on the electronic device 130 or electronic

device 130a” and that “the autonomous robot 1 of the present invention can be controlled remotely such that users can assign a working zone for the autonomous robot 1 or control the autonomous robot 1 through the electronic device 130 or electronic device 130a via the communication platform 110.” Hsu, [0021].

383. A POSITA would have understood that displaying this interactive map on the remote device constitutes “prompting a user” because the interface presents the user with the current status of the cleaning operation—including robot position, working area boundaries, and detected obstacles—and explicitly provides options to modify or define new boundaries or otherwise control the robot. This presentation of status information together with actional options solicits user engagement and invites a control decision. For example, viewing the map may prompt a user to define a “custom working boundary” if the current cleaning area is insufficient, or to redirerct the robot to a different zone. Thus, it is my opinion that the act of generating and displaying the interactive map with these boundary-setting and robot-control options on “external electronic device 130 or...130a” serves as the control response that prompts the user on a remote device as claimed.

384. As explained in §VII.F.1, a POSITA would have reasonably expected success in making such modification.

- b. 17[b] “wherein the method further comprises receiving a control input from the user on the remote**

**device for controlling a piece of equipment of the
swimming pool or spa.”**

385. In my opinion, the Knoll-Fu-007-Hsu combination discloses or suggests 17[b].

386. As explained in §VII.D.1 (Knoll summary), Knoll teaches that “a boundary line and/or boundary surface within the meaning of the invention is not necessarily to be understood as a line or surface directly delimiting the working area,” but rather “it is also possible to realize an embodiment in which the boundary line and/or the boundary surface is/are arranged at a distance from the outer boundaries of the working area.” Knoll, [0007]. This demonstrates that Knoll contemplates user-defined working boundaries that can be set within the pool area, not just following physical pool walls. This provides flexibility for users to define custom cleaning zones.

387. As explained in §VII.B.1 (Fu-007 summary), Fu-007 discloses “control signal buoyant antenna 27” that “floats on a water surface to wirelessly communicate with the control keyboard 31.” Fu-007, pp.8-10, 12-16, Claims 4-5, 7, FIG. 8. Fu-007 further teaches that “a control signal is sent by manual operation using the control keyboard, to directly or indirectly control the underwater cleaning robot via the control signal buoyant antenna.” *Id.*, pp.8-10, 14, Claim 5.

388. Hsu teaches that “users can set a working boundary for the autonomous

robot 1 on the display screen on the electronic device 130 or electronic device 130a” and that “the autonomous robot 1 of the present invention can be controlled remotely such that users can assign a working zone for the autonomous robot 1 or control the autonomous robot 1 through the electronic device 130 or electronic device 130a via the communication platform 110.” Hsu, [0021], FIG. 4.

389. In the Knoll-Fu-007-Hsu combination, users would provide control input by setting a working boundary on external electronic device 130 or 130a (remote device), defining the working zone for Knoll’s robotic vehicle 1 to clean. Hsu, [0021]. This control input would be transmitted via Hsu’s communication platform 110 to Fu-007’s wireless communication system (buoyant antenna 27) to Knoll’s control unit 11 operating underwater, which would then control robotic vehicle 1 (equipment) to operate within the user-defined working zone. Hsu, [0021]; Fu-007, pp.8-10, 12-17, Claims 4-5, 7, FIG. 8; Knoll, [0027]-[0028]. This constitutes “receiving a control input from the user on the remote device for controlling a piece of equipment of the swimming pool.”

390. A POSITA would have been motivated to combine Knoll, Fu-007, with Hsu, in addition to the reasons explained in §VII.F.1, to achieve Knoll’s explicitly mentioned goal that “the working area can be optimized” by enabling users to remotely define custom working boundaries “arranged at a distance from the outer

boundaries of the working area” via Hsu’s remote interface,” in addition to those as explained in §VII.F.2 (Claim 10). Knoll, [0007]; Hsu, [0021]. This modification would have allowed users to specify particular areas requiring cleaning (e.g., a heavily soiled section) without reprogramming the robot or physically adjusting pool-side equipment—a practical benefit that a POSITA would have recognized.

391. As explained in §VII.F.1, a POSITA would have reasonably expected success in making such modification.

392. Thus, it is my opinion that the Knoll-Fu-007-Hsu combination renders Claim 17 obvious.

G. Ground 3: Claims 2, 4, 7, 12, and 14-16 are Unpatentable over Laitta

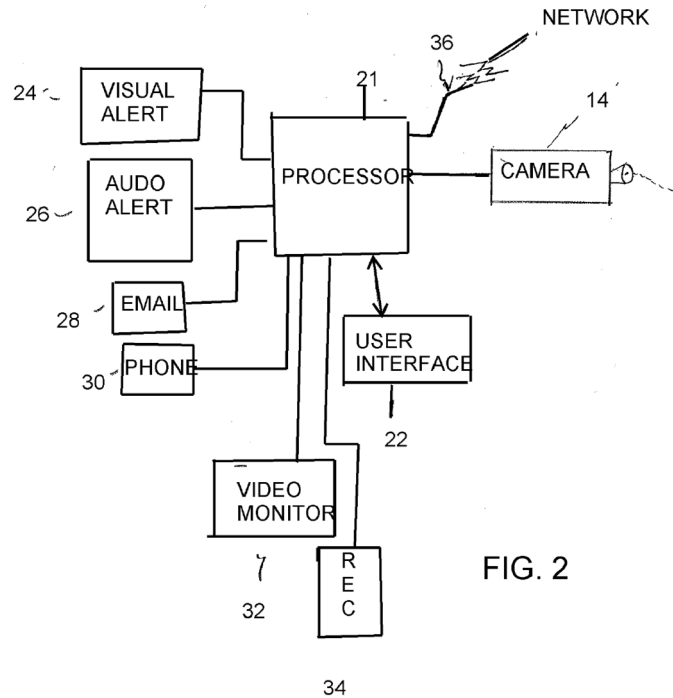
1. Claim 2

393. It is my opinion that Laitta (EX1012) discloses or suggests Claim 2.

a. 2[pre] “A pool system comprising:”

394. In my opinion, Laitta discloses or suggests the preamble.

395. Laitta discloses a “pool video safety, security and intrusion surveillance system” for monitoring “swimming pool areas.” Laitta, Title, Abstract, [0001]. Laitta’s system monitors “swimming pool 12” using cameras and control equipment. Laitta, [0016], FIG. 2.



b. 2[a] “at least one piece of equipment for a swimming pool or spa;”

396. It is my opinion that Laitta discloses or suggests 2[a].

397. The '207 Patent does not define “equipment for a swimming pool or spa,” but describes some device outputting “an alert...upon the **person’s detected presence.**” EX1001, 3:56–64. Similarly, Laitta’s system includes alert devices—“a visual alert (flashing light...)” and “audio alert (horn, bell...)”—triggered “[o]n detection of an alert condition” while monitoring “a swimming pool.” Laitta [0016]-[0018]. Laitta’s alert devices constitute “equipment for a swimming pool” because as part of Laitta’s system, they are installed and operate to detect entry into the pool’s monitoring area, consistent with the '207 Patent’s teaching.

c. **2[b] “one or more cameras configured to capture video or images of at least a portion of a location including the swimming pool or spa; and”**

398. It is my opinion that Laitta discloses or suggests 2[b].

399. Laitta’s pool system includes camera(s) 14 that observe swimming pool 12 and are “suitably positioned to have a view of the area being observed.” Laitta, [0016]-[0017], FIG. 1.

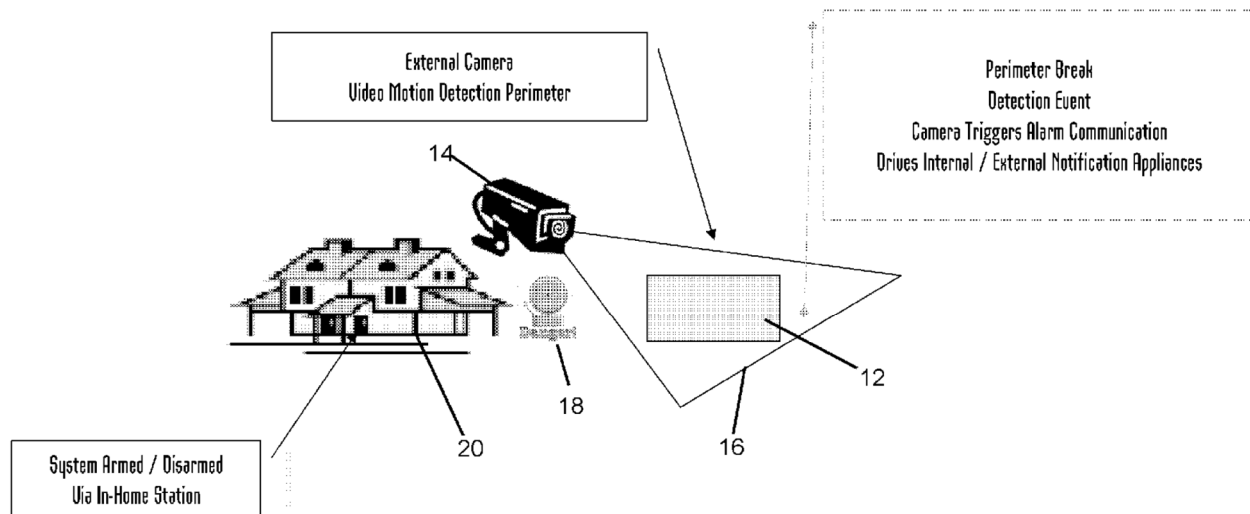
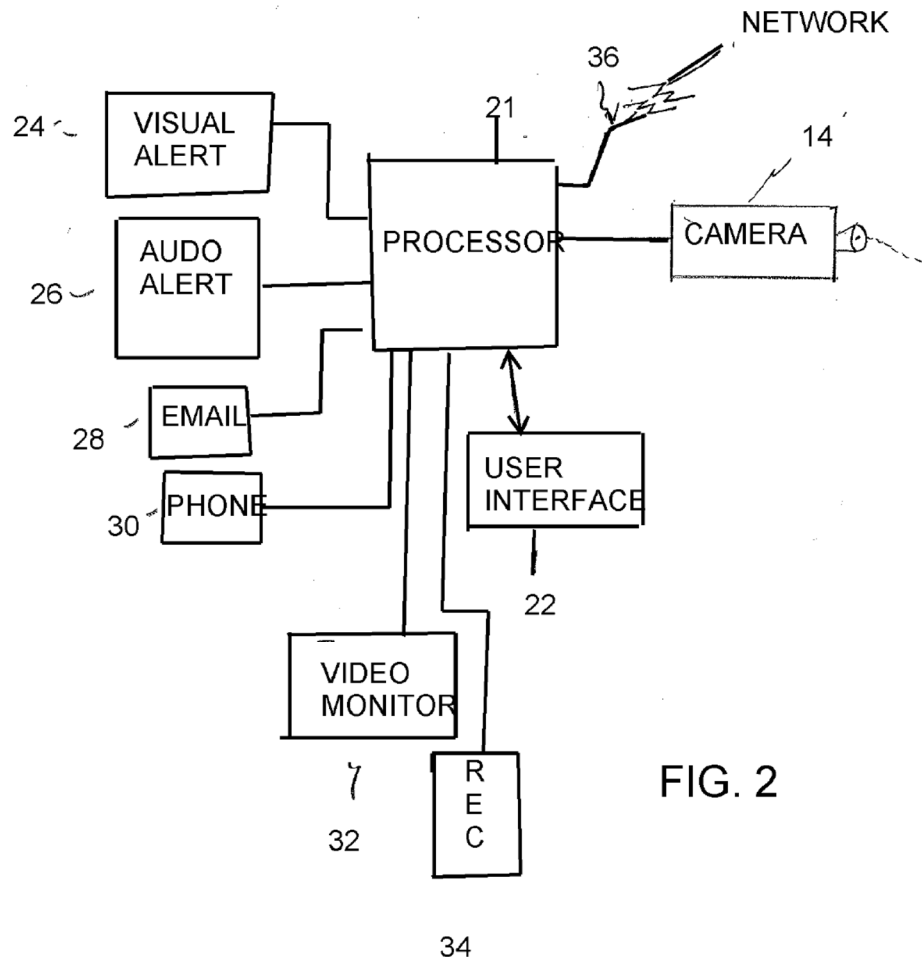


FIG. 1

400. Laitta describes sending “an email with attached images selected from **the images from the camera,**” “a video monitor 32...enabl[ing] viewing of the **image being supplied by the camera,**” and “a recorder 34...record[ing] **the images supplied by the camera 14.**” *Id.*, [0018]-[0019], FIG. 2. A POSITA would have understood that Laitta’s camera, which supplies images for viewing, emailing, and recording would have captured those images in the first place.

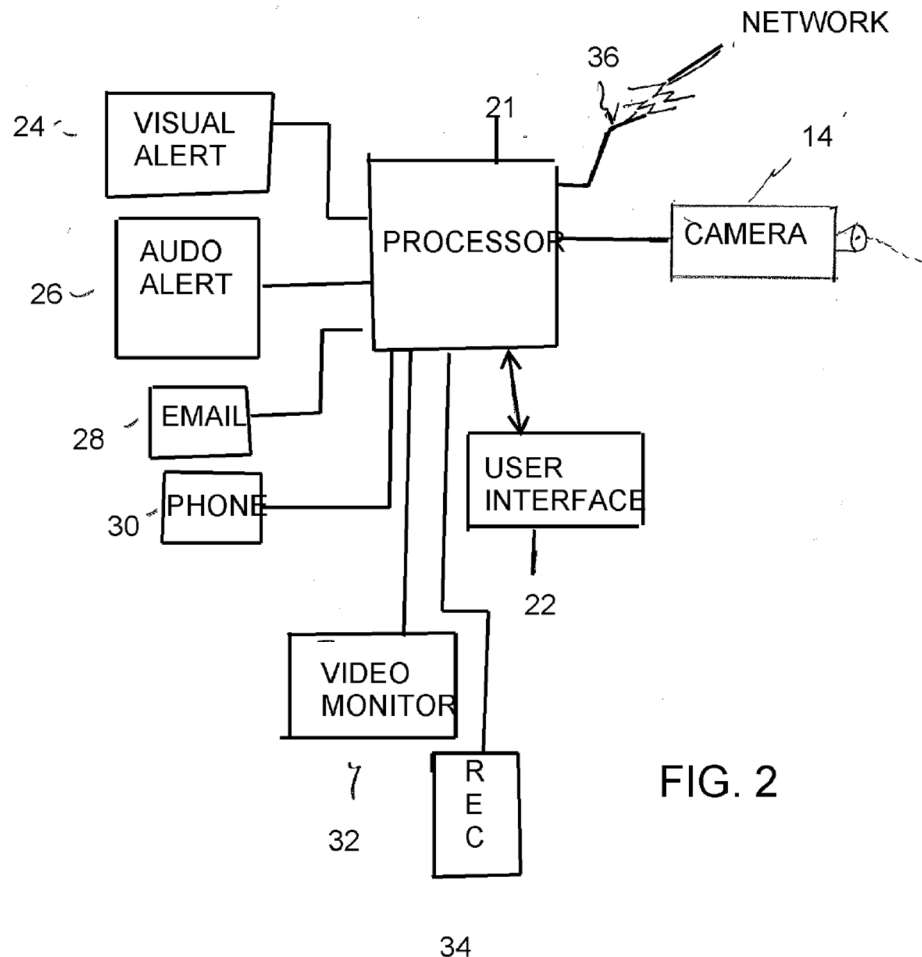


d. 2[c][i] “a controller in communication with the at least one piece of equipment and the one or more cameras,”

401. It is my opinion that Laitta discloses or suggests 2[c][i].

402. Laitta’s system includes a processor 21 (controller) in communication with the alert devices (equipment) and camera 14.

403. Laitta’s Figure 2 shows a processor 21 wired to camera 14 on one side and to the alert hardware on the other—visual alert 24, audio alert 26, email alert 28, and telephone alert 30.



404. Laitta describes that “[t]he output of the camera is supplied to a processor 21” and that the “processor...interfaces with a visual alert 24, an audio alert 26, an email...alert 28 and a telephone alert 30.” Laitta, [0017]. Laitta further explains operation: “[o]n detection of an alert condition as viewed by camera 14 and interpreted by processor 21, an alarm may be sounded,” including the visual, audio, email, and telephone alerts. Laitta, [0018]. Because processor 21 receives image data from camera 14 and drives the alert devices, it is a controller in communication with both the camera(s) and the equipment.

- e. **2[c][ii] “the controller configured to receive visual data from the one or more cameras and determine a control action for the at least one piece of equipment based on the received visual data.”**

405. It is my opinion that Laitta discloses or suggests 2[c][ii].

406. Laitta’s processor 21 (controller) receives visual/image data from camera 14. *See* §VII.G.1.d (2[c][i]). Laitta’s processor 21 also determines a control action for alert devices (equipment) based on the received visual data, because alerts are triggered “as viewed by camera 14 and interpreted by processor 21,” after which “an alarm may be sounded,” with the processor interfacing with “a visual alert..., an audio alert..., an email...alert...and a telephone alert.” Laitta, [0017]-[0018]. Laitta further explains the processor’s decision criteria—detecting “motion,” “size of object,” and “speed” to “determine whether an alarm event has taken place.” Laitta, [0020]. Laitta’s processor 21’s determining (and generating) alert signals constitutes “determine[ing] a control action” for alert devices (equipment) based on the received visual data, because Laitta’s processor 21 analyzes images to decide whether an alert event occurred and then activates the visual/audio/email/telephone alert hardware based on the received visual/image data. *Id.*

407. Therefore, it is my opinion that Laitta renders Claim 2 obvious.

2. Claim 4

408. In my opinion, Laitta discloses or suggests Claim 4 because Laitta’s

cameras are mounted external to swimming pool 12, as shown in Figure 1 (annotated below), aiming across an observation perimeter 16 around the pool, and labeled as an “External Camera” that detects motion and triggers alarms.

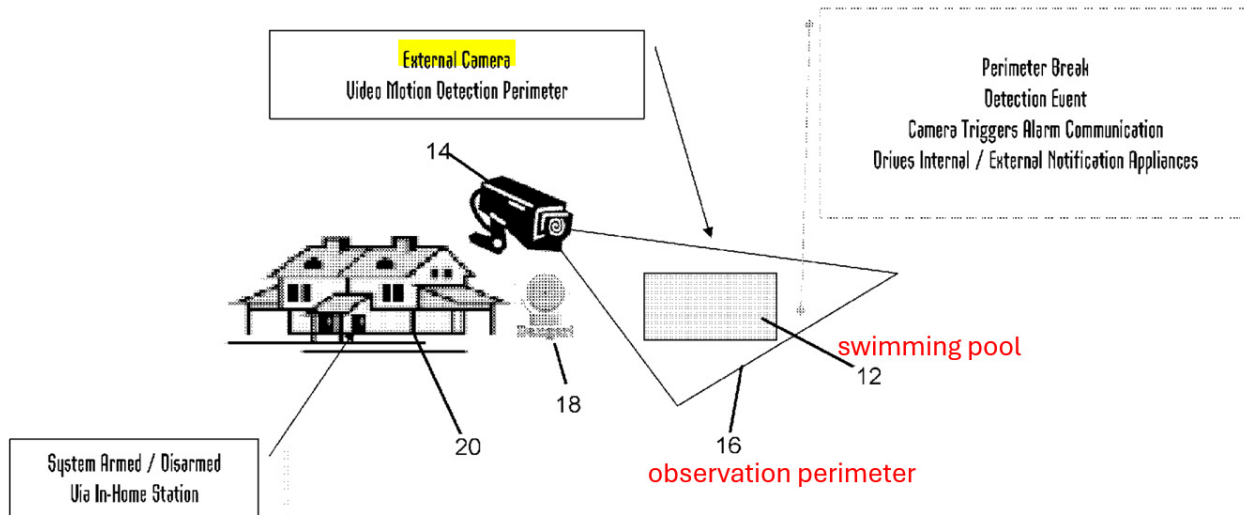


FIG. 1

409. The specification also describes that “a swimming pool 12 is observed by...cameras 14 which observe the pool area.” Laitta, [0016]. A POSITA would have understood that cameras observing the pool area from outside the water and monitoring a perimeter around the pool are mounted external to the pool.

410. Therefore, it is my opinion that Laitta renders Claim 4 obvious.

3. Claim 7

411. In my opinion, Laitta discloses or suggests Claim 7.

412. Laitta’s processor 21 (controller) receives visual data from camera 14. Laitta, [0017]-[0018]; *see also* §§VII.G.1.d-VII.G.1.e (elements 2[c][i]-[ii]). Laitta’s

processor 21 analyze the visual data to detect whether a person being present (a “human child or adult”) or the occurrence of an “alarm event” at a pool location. Laitta, [0020]. A POSITA would have understood that the presence of a person or the occurrence of an alarm event constitutes a “characteristic of the location” because it describes the instantaneous state—specifically, the occupancy or security status—of the monitored pool area.

413. Laitta’s processor 21 then controls the alert devices (equipment) to output alerts based on the detected characteristics (e.g., presence of a person). *See* §VII.G.1.e (2[c][ii]).

414. Therefore, it is my opinion that Laitta renders Claim 7 obvious.

4. Claim 12

415. In my opinion, Laitta discloses or suggests Claim 12.

a. 12[pre] “A method for monitoring a pool system, the method comprising:”

416. It is my opinion that Laitta discloses or suggests the preamble. Specifically, Laitta discloses “a pool video safety, security and intrusion surveillance system” that monitors “swimming pool areas” using cameras and processors to detect conditions and generate responses. Laitta, Title, Abstract, [0016]-[0018], FIGS 1-2; *see also* §VII.G.1 (Claim 2).

b. 12[a] “receiving images of at least a portion of a location including a swimming pool or spa from one or more cameras;”

417. In my opinion, Laitta discloses or suggests this limitation. Laitta’s processor 21 (controller) receives images from camera 14. Laitta, [0017]–[0019], FIG. 1; *see also* §§VII.D.3.d-VII.D.3.e (elements 2[c][i]-2[c][ii]). It is my opinion that A POSITA would have understood that these are “images of at least a portion of a location including a swimming pool” because Laitta explains that “swimming pool 12 is observed by...cameras 14 which observe the pool area” (FIG. 1, observation perimeter 16). Laitta [0016]–[0017], FIG. 1.

c. 12[b] “determining a target area and detecting a characteristic of the target area based on the images; and”

418. In my opinion, Laitta discloses or suggests this limitation.

419. Laitta discloses determining monitoring/monitored zones or sensing area (target area). Laitta, [0016]–[0018], [0022], FIG. 1. Specifically, Laitta teaches that “observation perimeter 16 (or multiple such perimeters or zones) is defined around the pool” and “monitoring zones may be set...which define monitored zones...used when determining alarm conditions,” while “areas in the field of view can be masked off or on so as to be ignored or specifically observed.” Laitta, [0016]–[0018], [0022], FIG. 1. Laitta’s system determines the target area by defining

observation perimeter 16 and/or monitoring/monitored/sensing zones and by applying masking/foreground–background separation so only the specifically observed (unmasked) regions are considered when determining alarm conditions. Laitta, [0016]–[0018], [0020], FIG. 1.

420. Laitta also discloses detecting a characteristic of the target area based on the images. Laitta’s processor 21 (controller) analyzes visual data to detect the presence of a person (e.g., a “human child or adult”) or the occurrence of an “alarm event” within the monitored zones (target area)]. *See* §VII.G.3 (Claim 7). A POSITA would have understood that this presence of a person or occurrence of an alarm event constitutes a characteristic of the target area (i.e., its occupancy or security status), which is detected based on the processor’s analysis of visual parameters like motion, size, and speed in the images.

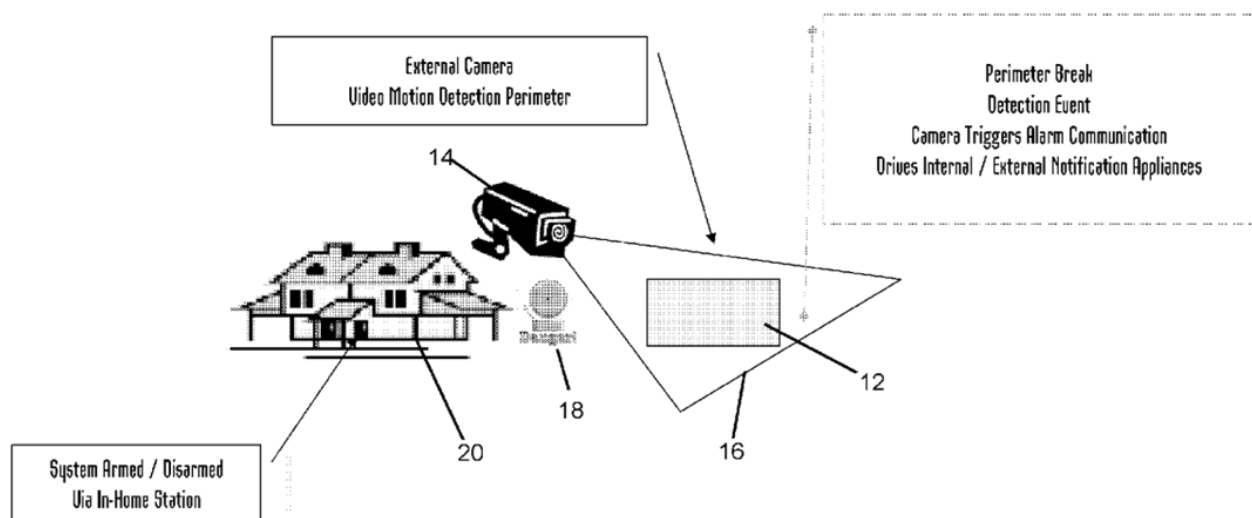


FIG. 1

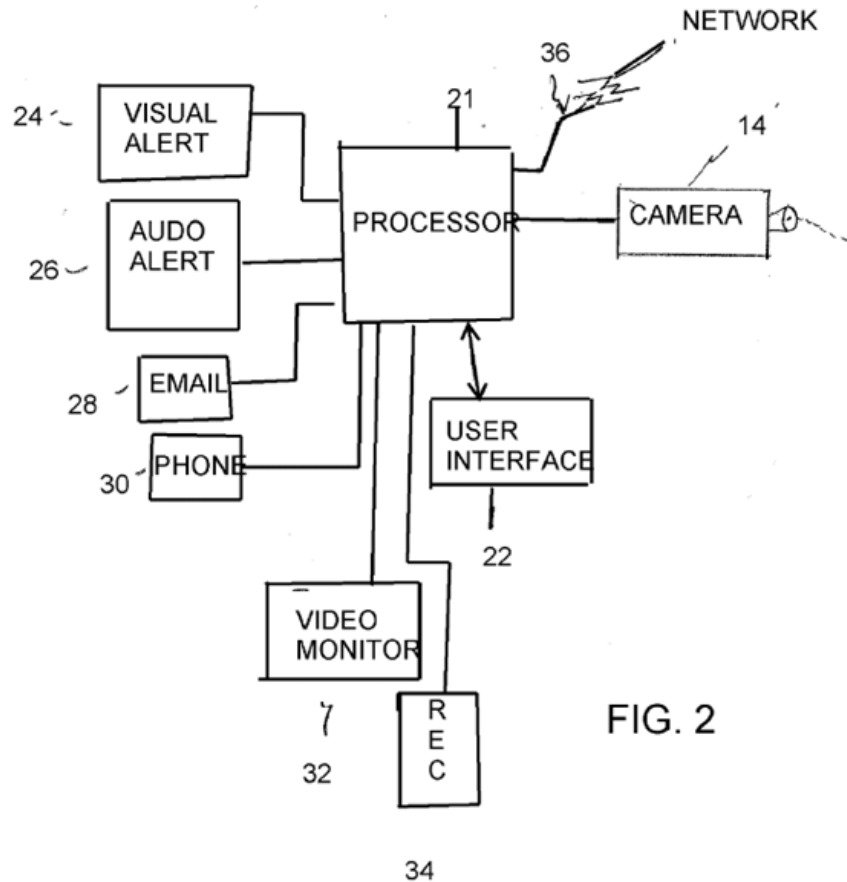
d. 12[c] “generating a control response based on the detected characteristic of the target area.”

421. In my opinion, Laitta discloses or suggests this limitation because its system generates a control response—actuating alert devices (visual alert 24, audio alert 26, an email alert 28, and/or telephone alert 30)—based on the detected occupancy or security status (characteristic) of monitoring/monitored/sensing zones (target area). Laitta, [0016]-[0018], [0020], FIGS. 1-2; *see also* §VII.G.1.e (element 2[c][ii]).

422. Therefore, it is my opinion that Laitta renders Claim 12 obvious.

5. Claim 14

423. It is my opinion that Laitta discloses or suggests Claim 14 because Laitta’s processor generates the control response by controlling the operation of pool equipment (alert device)—visual alert 24 (flashing light), audio alert 26 (horn/bell), and/or email alert 28—to produce an alert upon a detected occupancy or security status (characteristic) of monitoring/monitored/sensing zones (target area). Laitta [0016]–[0018], [0020], FIG. 2; *see also* §VII.G.1.b (2[a]) and §VII.G.4.d (12[c]).



424. Therefore, it is my opinion that Laitta renders Claim 14 obvious.

6. Claim 15

425. In my opinion, Laitta discloses or suggests Claim 15.

426. Laitta discloses generating an alert as the control response. *See* §VII.G.5 (claim 14). Laitta also discloses that the alert is on a remote device because it teaches an email alert “with attached images selected from the images from the camera” and a telephone alert that “might call one or more phone numbers (cell phone, neighbor’s home, etc.),” and further provides “video monitor 32...to enable viewing of the image...from a location remote from the pool,” enabled by interface

36. Laitta, [0018]–[0019], [0021], FIG. 2.

427. Therefore, it is my opinion that Laitta renders Claim 15 obvious.

7. Claim 16

428. In my opinion, Laitta discloses or suggests Claim 16 because Laitta’s alert (control response) includes a telephone alert calling (wireless communicating) a “cell phone” (remote device). Laitta, [0018]; *see also* §VII.G.4.d (element 12[c]). It is my opinion that Laitta also discloses an email alert (control response) “with attached images,” sent via interface 36 “adapted to connect to a network or other remote access technology,” which a POSITA would have understood or found obvious to be delivered wirelessly (cellular/Wi-Fi) to a remote device such as a cell phone. Laitta, [0018], [0021].

429. Therefore, it is my opinion that Laitta renders Claim 16 obvious.

VIII. CONCLUSION

430. Based on the foregoing analysis, it is my opinion that the challenged claims of the ’207 patent are invalid.

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; that these statements were made with knowledge that willful false statements and

the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001; and further that such willful false statements may jeopardize the validity of the application or any patent issued thereon. I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

This declaration and my opinions herein are made to the best of my knowledge and understanding, and based on the material available to me, at the time of signing this declaration. I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 or Title 18 of the United States Code.

Dated: January 26, 2026

By: _____

Jason Janet, Ph.D.