

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XINGMAI INNOVATION TECHNOLOGY (SUZHOU) CO., LTD.
D/B/A BEATBOT
Petitioner,

v.

AIPER GLOBAL PTE. LTD.
Patent Owner.

Case No. PGR2026-00012
U.S. Patent No. 12,221,196

**PETITION FOR *POST-GRANT* REVIEW
OF U.S. PATENT NO. 12,221,196**

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1001	U.S. Patent No. 12,221,196 to Liu et al. (“the ’196 Patent”)
1002	Prosecution file history for the ’196 patent
1003	Declaration of Dr. Noah Cowan
1004	<i>Curriculum Vitae</i> of Dr. Noah Cowan
1005	U.S. Patent Application Publication No. 2025/0146315, published May 8, 2025 to Wang et al. (“Wang”)
1006	Certified Translation of International Patent Application No. PCT/CN2024/076040 (published as WO 2024/169737), filed February 5, 2024 (“Wang ’040”)
1007	International Patent Application No. PCT/CN2024/076040 (published as WO 2024/169737), filed February 5, 2024 (“Wang ’040”)
1008	Chart of subject matter of Wang as supported by Wang ’040
1009	U.S. Patent No. 11,946,282, issued April 2, 2024 to Zhang (“Zhang”)
1010	Certified Translation of Chinese Patent No. CN117738506, published March 22, 2024 to Guo et al. (“Guo”)
1011	Chinese Patent No. CN117738506 (“Guo”)
1012	U.S. Patent No. 11,803,193, issued October 31, 2023 to Zhao et al. (“Zhao”)
1013	International Patent Application No. PCT/US2007/063650 (published as WO 2007/106730), published September 20, 2007 (“Owen”)
1014	U.S. Patent Application Publication No. 2003/0201218, published October 30, 2003 to Henkin et al. (“Henkin ’218”)

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Exhibit No.	Description
1015	U.S. Patent No. 5,985,156, issued November 16, 1999 to Henkin et al. (“Henkin ’156”)
1016	Certified Translation of Chinese Patent No. CN 117661894, published on March 8, 2024 (“Deng”)
1017	Chinese Patent No. CN 117661894, published on March 8, 2024 (“Deng”)
1018	Certified Translation of Chinese Patent No. CN 116166018, published on May 26, 2023 (“Liu”)
1019	Chinese Patent No. CN 116166018, published on May 26, 2023 (“Liu”)
1020	Publication J41 in the <i>Curriculum Vitae</i> of Dr. Noah Cowan
1021	Plot and Code of Simulation for Airbag Inflation
1022	Chapter 9: “Timers” of <i>Programmable Logic Controllers</i> , 6th Edition, W. Bolton, published in 2015
1023	U.S. Patent No. 11,124,982 to Korenfeld et al. (“Korenfeld”)
1024	U.S. Patent No. 11,274,462 to Tryber et al. (“Tryber”)

LISTING OF CLAIMS

Element	Claim 1
[1pre]	A controllable sinking and floating swimming pool robot, comprising:
[1a]	a sinking and floating control unit configured to control a swimming pool robot to float and sink;
[1b]	a waterline detection unit configured to detect a positional relationship between the swimming pool robot and a waterline of a liquid surface of a swimming pool where the swimming pool robot is located; and
[1c]	a main control unit configured to control a working state of the sinking and floating control unit,
[1d]	wherein the main control unit is capable of controlling the swimming pool robot to find a side wall or a slope based on operational requirement information of the swimming pool robot and enabling the swimming pool robot to crawl along the side wall or the slope;
[1e]	controlling the waterline detection unit to detect the positional relationship between the swimming pool robot and the waterline of the liquid surface of the swimming pool where the swimming pool robot is located; and
[1f]	controlling the sinking and floating control unit to enter a floating working state based on detection results to realize a floating of the swimming pool robot,
[1g]	wherein the sinking and floating control unit is controlled to stop working after the sinking and floating control unit enters the floating working state for a predetermined time.
Element	Claim 2
[2a]	The controllable sinking and floating swimming pool robot according to claim 1, further comprising a posture detection unit configured to detect a posture of the swimming pool robot,

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[2b]	wherein the main control unit controls the waterline detection unit to start detecting the positional relationship in response to the posture meeting a first predetermined condition.
	Claim 3
3	The controllable sinking and floating swimming pool robot according to claim 1, wherein the operational requirement information comprises remote control command information sent by a user, clock information, operational task progress information, fault information, power information or swimming pool bottom environment information.
	Claim 4
4	The controllable sinking and floating swimming pool robot according to claim 1, further comprising a distance measurement unit or a map storage unit, wherein the main control unit controls the swimming pool robot to find the nearest side wall or the nearest slope based on distance measurement results of the distance measurement unit or map data in the map storage unit.
	Claim 5
5	The controllable sinking and floating swimming pool robot according to claim 1, wherein the waterline detection unit comprises an outlet water detection subunit configured to detect whether at least a part of the swimming pool robot has come out of water.
	Claim 6
6	The controllable sinking and floating swimming pool robot according to claim 1, wherein the waterline detection unit further comprises a proximity waterline detection subunit configured to detect whether the swimming pool robot has crawled to a distance less than or equal to a predetermined distance from the waterline.
Element	Claim 7
[7a]	The controllable sinking and floating swimming pool robot according to claim 5, wherein the sinking and floating control unit comprises an inflation and deflation subunit and a switch subunit,

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[7b]	wherein in response to the outlet water detection subunit detecting that at least a part of the swimming pool robot has come out of the water, the inflation and deflation subunit is controlled to start sucking air and the switch subunit is controlled to open, so that the sinking and floating control unit enters the floating working state.
Element	Claim 8
[8a]	The controllable sinking and floating swimming pool robot according to claim 5, wherein the sinking and floating control unit comprises an inflation and deflation subunit and a switch subunit,
[8b]	wherein in response to the proximity waterline detection subunit detecting that the swimming pool robot has crawled to the distance less than or equal to the predetermined distance from the waterline, the inflation and deflation subunit is controlled to start sucking air,
[8c]	and in response to the outlet water detection subunit detecting that at least a part of the swimming pool robot has come out of the water, the switch subunit is controlled to open, so that the sinking and floating control unit enters the floating working state.
Element	Claim 9
[9a]	The controllable sinking and floating swimming pool robot according to claim 7, wherein the sinking and floating control unit further comprises an airbag subunit connected to the inflation and deflation subunit, wherein the airbag subunit is connected to or disconnected from outside atmosphere through the inflation and deflation subunit and the switch subunit,
[9b]	and wherein the sinking and floating control unit further comprises an air inlet and outlet subunit, wherein the switch subunit is connected to the outside atmosphere through the air inlet and outlet subunit.
	Claim 10
10	The controllable sinking and floating swimming pool robot according to claim 1, wherein the main control unit is further capable of controlling the sinking and floating control unit to enter a sinking working state based on the operational requirement information of the swimming pool robot to realize a sinking of the swimming pool robot.

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	Claim 11
11	The controllable sinking and floating swimming pool robot according to claim 10, wherein the sinking and floating control unit comprises an inflation and deflation subunit, a switch subunit and an airbag subunit connected to the inflation and deflation subunit, controlling the sinking and floating control unit to enter the sinking working state comprises controlling the switch subunit to open and controlling the inflation and deflation subunit to discharge air in the airbag subunit.
Element	Claim 12
[12a]	The controllable sinking and floating swimming pool robot according to claim 7, wherein the inflation and deflation subunit comprises an air pump assembly,
[12b]	and the switch subunit comprises an electromagnetic valve assembly or a two-position three-way valve assembly.
	Claim 13
13	The controllable sinking and floating swimming pool robot according to claim 7, wherein in response to the outlet water detection subunit detecting that at least a part of the swimming pool robot enters underwater again and/or the posture detection unit detecting that the posture of the swimming pool robot meets a second predetermined condition, the inflation and deflation subunit and the switch subunit are controlled to be closed.
Element	Claim 14
[14a]	The controllable sinking and floating swimming pool robot according to claim 7, further comprising a water pump unit configured to pump liquid in the swimming pool where the swimming pool robot is located and discharge the liquid to drive the swimming pool robot,
[14b]	wherein a power of the water pump unit is changed after the sinking and floating control unit enters the floating working state or after the swimming pool robot climbs the side wall or the slope.

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Element	Claim 15
[15pre]	A sinking and floating control method for a swimming pool robot, comprising:
[15a]	controlling a swimming pool robot to find a side wall or a slope based on operational requirement information of the swimming pool robot, and enabling the swimming pool robot to crawl along the side wall or the slope;
[15b]	detecting a positional relationship between the swimming pool robot and a waterline of a liquid surface of a swimming pool where the swimming pool robot is located;
[15c]	controlling a sinking and floating control unit to enter a floating working state based on detection results to realize a floating of the swimming pool robot; and
[15d]	controlling the sinking and floating control unit to stop working after the sinking and floating control unit enters the floating working state for a predetermined time.
Claim 16	
16	The sinking and floating control method for the swimming pool robot according to claim 15, wherein detecting the positional relationship between the swimming pool robot and the waterline of the liquid surface of the swimming pool where the swimming pool robot is located comprises: starting detecting the positional relationship in response to a posture of the swimming pool robot meeting a first predetermined condition.
Claim 17	
17	The sinking and floating control method for the swimming pool robot according to claim 16, wherein the operational requirement information comprises remote control command information sent by a user, clock information, operational task progress information, fault information, power information or swimming pool bottom environment information.

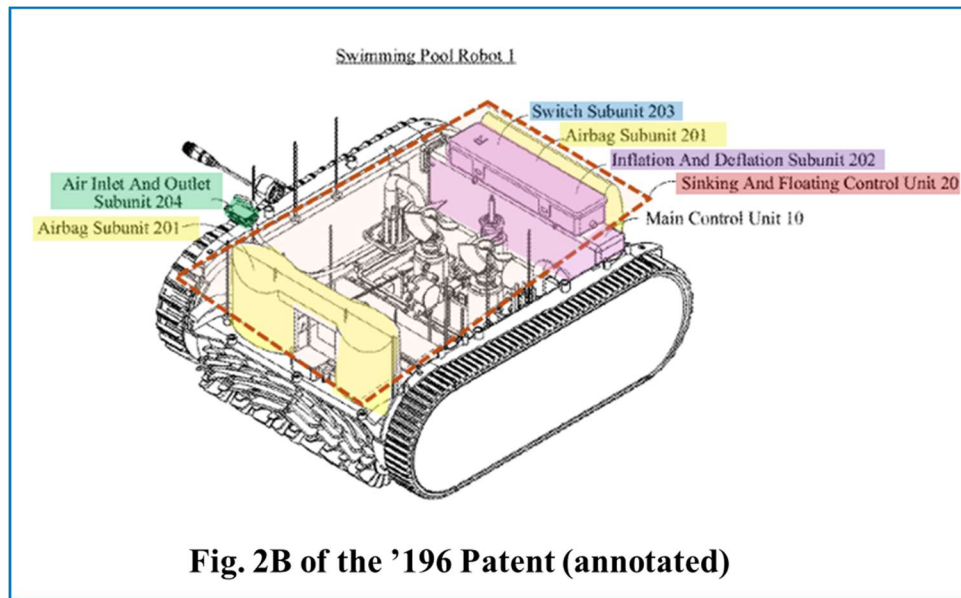
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	Claim 18
18	The sinking and floating control method for the swimming pool robot according to claim 17, wherein controlling the sinking and floating control unit to enter the floating working state based on detection results to realize the floating of the swimming pool robot comprises: controlling the sinking and floating control unit to enter the floating working state in response to detecting that at least a part of the swimming pool robot has come out of water.
	Claim 19
19	The sinking and floating control method for the swimming pool robot according to claim 17, further comprising: controlling the sinking and floating control unit to stop working in response to detecting that at least a part of the swimming pool robot enters underwater again and/or detecting that the posture of the swimming pool robot meets a second predetermined condition.

I. INTRODUCTION

Petitioner requests Post-Grant Review (“PGR”) of claims 1-19 (“Challenged Claims”) of U.S. Patent No. 12,221,196 (the “’196 Patent,” EX1001). The Board should institute PGR because this Petition, supported by the declaration of Dr. Noah Cowan (EX1003), demonstrates it is more likely than not that at least one Challenged Claim is unpatentable.

The ’196 Patent concerns a pool-cleaning robot capable of sinking and floating. EX1001, 4:21-31. According to the specification, prior art devices adjusted buoyancy by absorbing or discharging water to vary the robot’s mass—an approach characterized as slow and inefficient. EX1001, 1:27-33. The ’196 Patent purports to improve this process through a “sinking and floating control unit” comprising pumps, valves, and airbags connected to an inlet/outlet system that inflates and deflates the airbags. EX1001, Fig. 2B, 3; 6:31-59; 6:66-7:8; 7:36-54.



The '196 Patent describes its principal advance as “inflating and deflating the airbag,” drawing air from above the waterline to accelerate transitions between operating states. EX1001, 4:21-31. However, long before the July 26, 2024, priority date, the same air-based buoyancy architecture was conventional in aquatic robotics.

Multiple prior art references disclosed processor-controlled air-based buoyancy systems for pool-cleaning robots that transitioned between sinking and floating modes. EX1003, ¶¶174-228. The same references taught waterline sensing, depth sensing, and common feedback mechanisms—using inertial (IMU), ultrasonic, and/or pressure sensors—for navigation, posture, and stability. *Id.*

The feature the Examiner identified as distinguishing over the prior art—automatically stopping the “sinking and floating control unit” after it has entered the floating working state **for a predetermined time**—was itself well known. EX1002,

p.157. Timer-controlled pump shutoffs for inflating airbags were routinely used to prevent overinflation and protect components. EX1013, 1:30-2:15; 3:19-4:10. Incorporating a timer-based shutoff into these established air-based buoyancy systems would have been a straightforward and predictable design choice, motivated by the same objective cited in the '196 Patent—namely, preventing prolonged inflation and protecting the airbag system once floating was achieved. EX1001, 9:25-28.

In sum, every structural and functional element of the '196 Patent's buoyancy control system was previously disclosed and would be obvious to a person of ordinary skill in the art ("POSITA").

Claims 1-14 are also indefinite on multiple grounds.¹ Petitioner respectfully requests that the Board find all Challenged Claims unpatentable as obvious and claims 1-14 unpatentable for failing the requirements of §112.

II. REQUIREMENTS FOR POST GRANT REVIEW

This Petition complies with all statutory requirements and 37 C.F.R. §§42.201 et seq. and should be accorded a filing date pursuant to 37 C.F.R. §42.206.

¹ While the outer bounds of the claims are not reasonably certain, the Board can nevertheless find these claims unpatentable as obvious. *See Intel Corp. v. Qualcomm Inc.*, 21 F.4th 801, 812-14 (Fed. Cir. 2021).

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A. Grounds for Standing

Petitioner certifies that the '196 Patent is available for PGR and that Petitioner is not barred or estopped from requesting PGR challenging claims 1-19. 37 C.F.R. §42.204(a); 35 U.S.C. §325(e)(1).

This Petition is filed less than 9 months after the issue date of the '196 patent (February 11, 2025). 37 C.F.R. §42.202; 35 U.S.C. §321(c).

The '196 Patent is eligible for PGR because it issued from a patent application filed after enactment of the America Invents Act ("AIA").

B. Identification of Challenge and Requested Relief

Under 37 C.F.R. §§42.204(b) and 42.22, Petitioner requests that the Board institute PGR on the Challenged Claims and cancel them as unpatentable. The prior art references combined to form the Grounds are:

Exhibit No.	Reference	Prior Art
1005	U.S. Pub. 2025/0146315 ("Wang") ²	Post-AIA §102(a)(2)
1009	U.S. Pat. 11,946,282 ("Zhang") ³	Post-AIA §102(a)(1)

² Wang was filed Jan. 18, 2025 (EX1005) and claims priority as a CIP of PCT/CN2024/076040, filed Feb. 5, 2024, and published as WO2024/169737 August 22, 2024. EX1006.

³ Zhang was filed July 17, 2023, and published April 2, 2024. EX1009.

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Exhibit No.	Reference	Prior Art
1010	Chinese Pat. CN117738506 (“Guo”) ⁴	Post-AIA §102(a)(1)
1012	U.S. Pat. 11,803,193 (“Zhao”) ⁵	Post-AIA §102(a)(1)
1013	Int’l Pub. WO 2007/106730 (“Owen”) ⁶	Post-AIA §102(a)(1)

The Grounds asserted are:

Ground	Claims Challenged	35 U.S.C. §	Reference(s)/Basis
1	1-7, 9-11, 13-19	103	Obviousness over Wang in view of Zhao and Owen
2	8, 12		Obviousness over Wang in view of Zhao, Owen, and Guo
3	1-6, 10, 14-17		Obviousness over Zhang in view of Zhao and Owen
4	1-8, 10-13, 15-19		Obviousness over Guo in view of Zhao and Owen
5	1-14	112(b)	Indefinite
6	4		Indefinite

⁴ Guo was filed January 23, 2024, and published March 22, 2024. EX1010.

⁵ Zhao was filed January 3, 2023, and issued October 31, 2023. EX1012.

⁶ Owen was filed March 9, 2007, and published September 20, 2007. EX1013.

III. CLAIM CONSTRUCTION

In PGR, claim terms are construed under *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*) and its progeny. 37 C.F.R. §42.200(b). The Board, however, only construes claim terms when necessary to resolve the controversy. *See, e.g., Toyota Motor Corp. v. Cellport Sys., Inc.*, No. IPR2015-00633, Paper No. 11 at 16 (PTAB. Aug. 14, 2015). Petitioner submits that only the terms addressed in Grounds 5-6 (regarding indefiniteness) and the terms below require construction for this proceeding.

A. “sinking and floating control unit” (Claims 1-19)

Subject to §112(f). EX1003, ¶¶76-86. **Structure:** an air-based buoyancy control assembly, described in FIG.3-5 and 6:66-8:5 of EX1001, and equivalents thereof.

B. “waterline detection unit” (Claims 1-14)

Subject to §112(f). EX1003, ¶¶92–98. **Structure:** a capacitive or ultrasonic sensor, described in FIG.1 and 5:58-6:17; 8:24-47 of EX1001, and equivalents thereof.

C. “posture detection unit” (Claims 2, 13)

Subject to §112(f). EX1003, ¶¶99-107. **Structure:** an IMU, described in FIG.1 and 9:29-57; 12:5-21 of EX1001, and equivalents thereof.

D. “outlet water detection subunit” (Claims 5, 7-9, 12-14)

Subject to §112(f). EX1003, ¶¶118-126. **Structure:** a capacitive or ultrasonic sensor, described in FIG.1 and 8:29-40 of EX1001, and equivalents thereof.

E. “proximity waterline detection subunit” (Claims 6, 8)

Subject to § 112(f). EX1003, ¶¶127-137. **Structure:** an ultrasonic sensor, described in FIG.1 and 8:29-47 of EX1001, and equivalents thereof.

F. “inflation and deflation subunit” (Claims 7-9,11-14)

Subject to § 112(f). EX1003, ¶¶138–146. **Structure:** air pump, described in FIG.1,3-5 and 7:19-8:15 of EX1001, and equivalents thereof.

IV. LEVEL OF ORDINARY SKILL IN THE ART

A POSITA with respect to the '196 Patent would have possessed at least a bachelor's degree in mechanical engineering, electrical engineering, mechatronics, robotics, computer engineering, or a closely related field; and at least three years of experience in the design, development, and control of mobile or underwater robotic systems, including work with buoyancy control systems, sensor integration, and embedded firmware or control algorithms. EX1003, ¶22.

V. OVERVIEW OF THE '196 PATENT

A. Summary Of The '196 Patent

The '196 Patent concerns techniques for controlling buoyancy in a pool-cleaning robot so it can operate both underwater and at the surface by switching between sinking and floating states. EX1001, 1:37-40.

Figure 3 depicts a **sinking and floating control unit** comprising two **airbag subunits**, arranged at the front and rear of the robot, the **inflation and deflation subunit**, the **switch subunit**, and the **air inlet and outlet subunit**. EX1001, 6:66-7:8, FIG3.

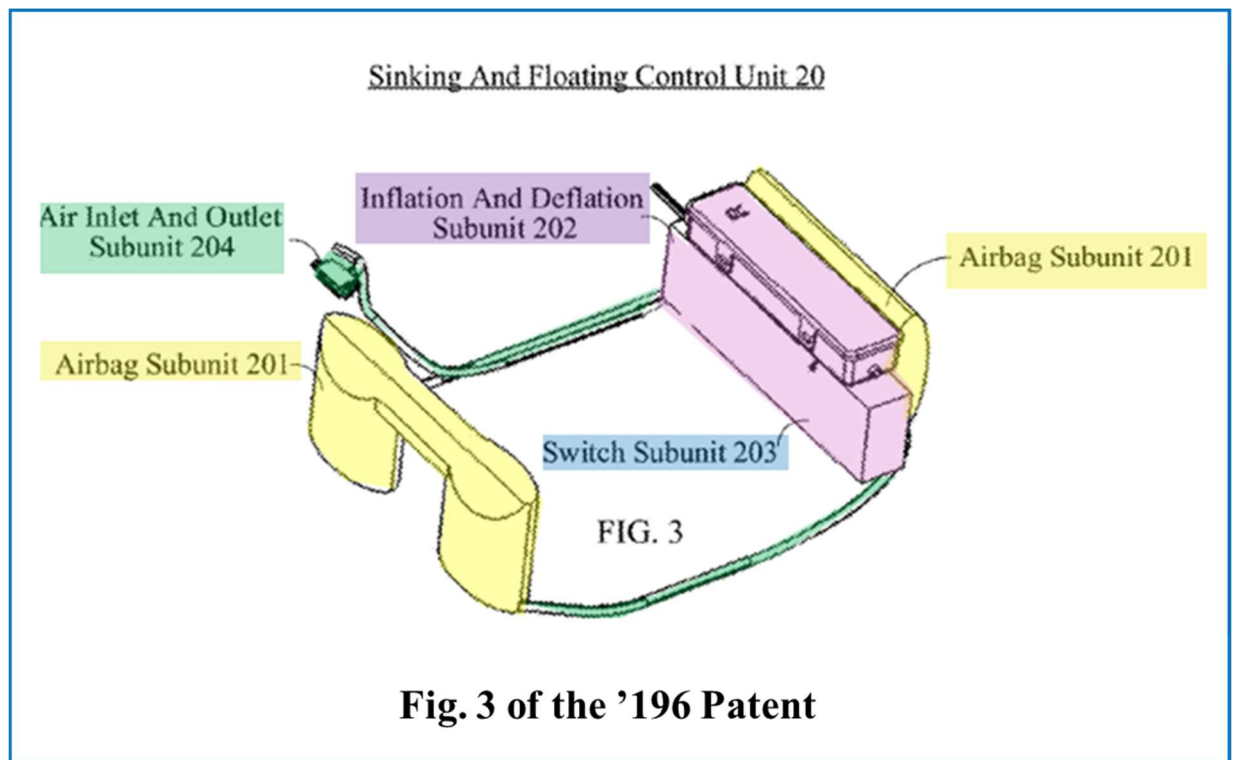
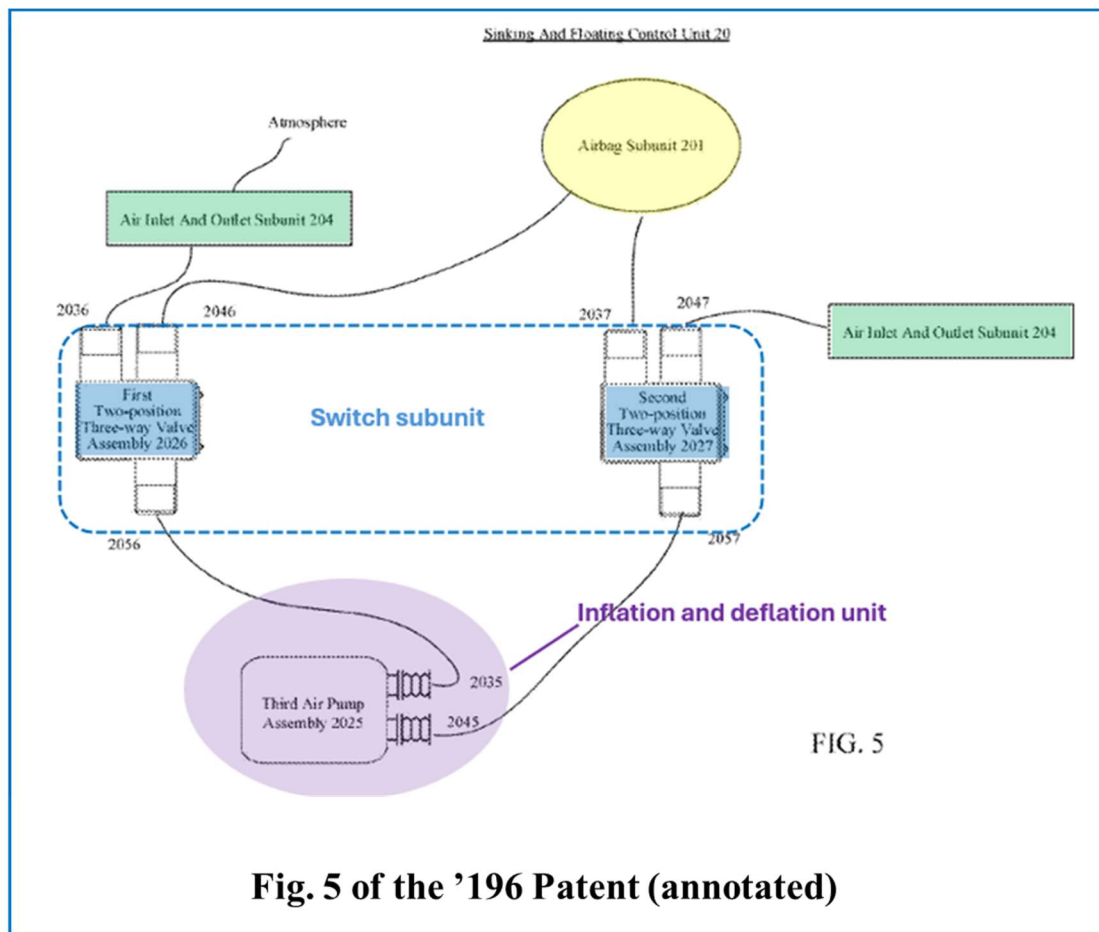


Figure 5 illustrates the pneumatic connections. The **inflation and deflation subunit (e.g., pumps)**, **switch subunit (e.g., valves)**, and the **airbag subunits** are connected to an **inlet/outlet system** that selectively inflates/deflates the airbags to adjust buoyancy. EX1001, 7:55-8:23, FIG5. Inflating the airbags increases buoyancy, causing the robot to float, while releasing air from the airbags decreases buoyancy, causing the robot to sink. *Id.*



The '196 Patent also discloses a wall-finding routine implemented via either distance ranging or stored mapping: a **distance measurement unit** performs range

measurements to identify the nearest side wall or slope (EX1001, 9:58-66), and a **map storage unit** stores pool map data that the main control unit may use to make the same determination (EX1001, 10:4-7). The **main control unit** then directs the robot to the nearest side wall or slope and commands it to crawl along that surface to the water surface. EX1001, 9:66-3, 10:7-11.

For buoyancy control, the '196 Patent discloses sensor-based detection modules. A **waterline detection unit** includes an **outlet-water detection subunit** that identifies when a portion of the robot has emerged and a **proximity-to-waterline subunit** that detects when the robot is within a preset distance of the surface. EX1001, 8:29-56. A **posture detection unit**, such as an inertial sensor or IMU, measures tilt and orientation. EX1001, 9:29-32. The **main control unit** uses these inputs to recognize state transitions (for example, from wall-climbing to floating operation) and to command sinking or floating actions. EX1001, 5:63-6:2, 9:32-47.

Finally, the main control unit stops the sinking and floating control unit after it enters the **floating working state** for a **predetermined time**, implementing a timer-based cutoff that prevents overinflation and protects the airbags from damage. EX1001, 9:5-28.

B. Prosecution History

The '196 Patent issued from Application No. 18/822,334 (“’334 Application”), filed on September 2, 2024, and claims priority to Chinese Patent Application No. 202411017697.3 filed on July 26, 2024.

During original prosecution, the Examiner rejected claims 1, 3, 5, 10, and 16-19 under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 11,124,982 (“Korenfeld,” EX1023) in view of U.S. Patent No. 11,274,462 (“Tryber,” EX1024). EX1002, 121-123.

Applicant amended allowable claim 14 and added “wherein **the sinking and floating control unit is controlled to stop working** after the sinking and floating control unit enters the floating working state for a predetermined time”⁷ into independent claims 1 and 16. EX1002, 128, 132; EX1003, ¶64.

In the Notice of Allowance, Examiner stated that the prior art does not show or suggest “*the use of a robot and method which include a sinking and floating control unit that is controlled **to stop working after said unit enters a floating working state for a predetermined time.***” EX1002, 157.

The '196 Patent only cites two prior art references (Korenfeld and Tryber) identified by the Examiner.

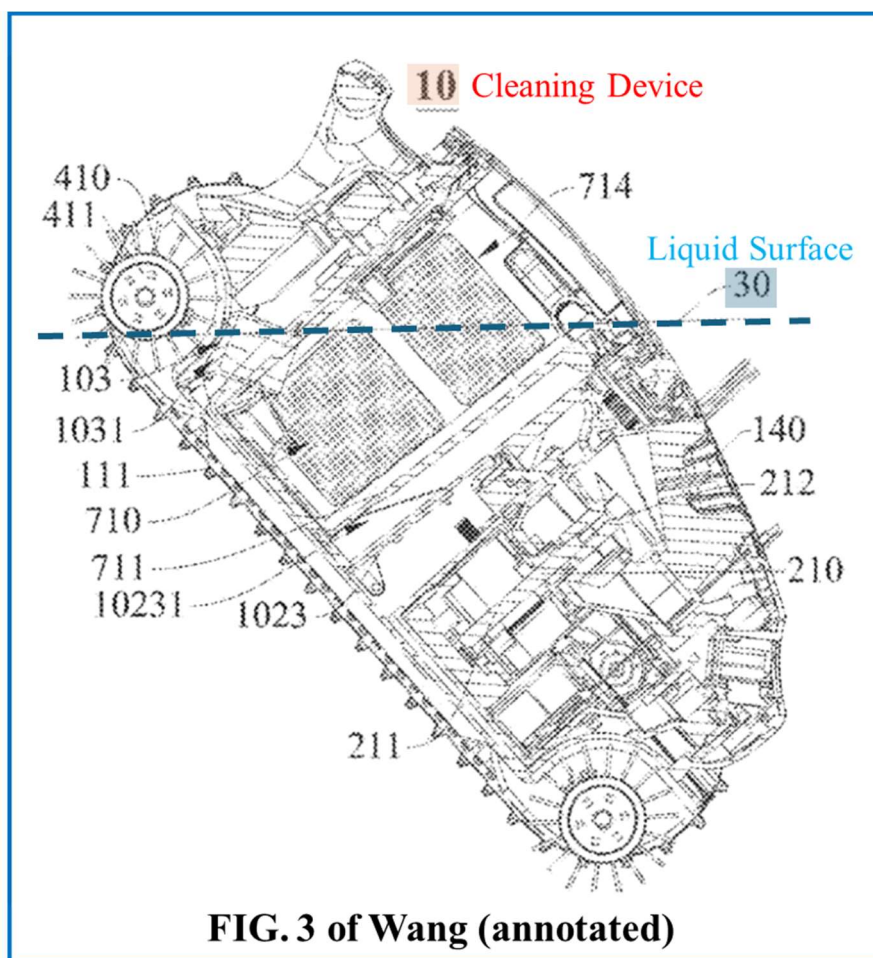
⁷ All cited portions in bold are added for emphasis, unless otherwise indicated.

VI. OVERVIEW OF THE STATE OF THE ART

A. Wang (EX1005)

Wang is prior art under 35 U.S.C. §102(a)(2) because its CIP parent, Wang '040 (EX1006), filed February 5, 2024, fully supports the disclosure in Wang relied upon in this Petition. EX1003, ¶180; EX1008.

Wang discloses a pool-cleaning robot capable of **autonomously switching between floating and submerged states** for cleaning. EX1005, ¶[0064]. To achieve this, Wang teaches a **mode-switching member**, a **buoyancy cavity** with an inflation/deflation pump, and a **first sensor for real-time depth measurement**, and a **second sensor** that detects whether the **air inlet is exposed to air**. EX1005, ¶¶[0067], [0109]-[0111], [0113]-[0115].



Once the preset conditions are met, Wang's **controller** activates the pump to inflate the **buoyancy cavity** and raise the robot to the surface, then reduces buoyancy after a defined interval to submerge the robot again. EX1005, ¶¶[0114], [0120]. Wang's **main water pump** generates suction for **wall climbing**, and this suction power is reduced or stopped when the robot disengages from the wall or floats at the surface. EX1005, ¶¶[0144]-[0145].

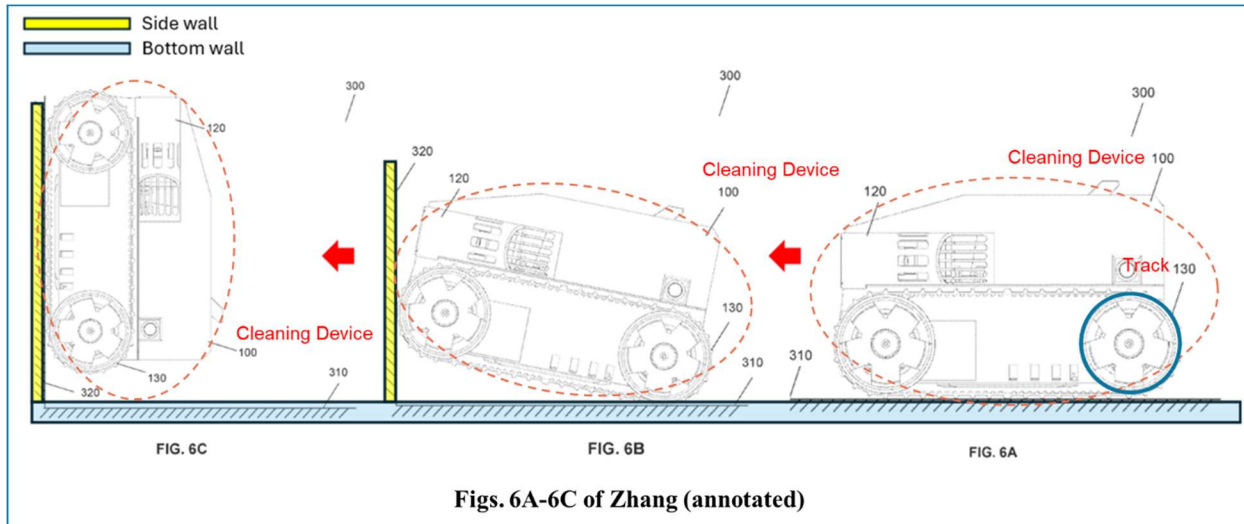
B. Zhang (EX1009)

Zhang was published on April 2, 2024, and is prior art under 35 U.S.C. §102(a)(1).

Zhang discloses a pool-cleaning robot equipped with a **mode-switching member**—a sinking and floating control unit that adjusts buoyancy, allowing the robot to float or sink. EX1009, Abstract, 4:24-27, 4:31-35, 4:57-62. The mode-switching member includes a **buoyancy-adjustment assembly** comprising an **inflatable buoyancy cavity** and a **buoyancy-adjustment member** equipped with pump, air inlet, and air pipe. EX1009, 5:1–3, 6:25–7:4.

Zhang further teaches a **processor-controlled transition** between submerged and floating states using **sensor feedback**: a first sensor measures **real-time depth and position**, while a second sensor detects when the **air inlet is exposed to air**. EX1009, 7:35–39, 8:13–16. When preset conditions are met—such as when part of the robot emerges above the surface—the processor increases gas in the buoyancy cavity to enable floating. EX1009, 8:28–31.

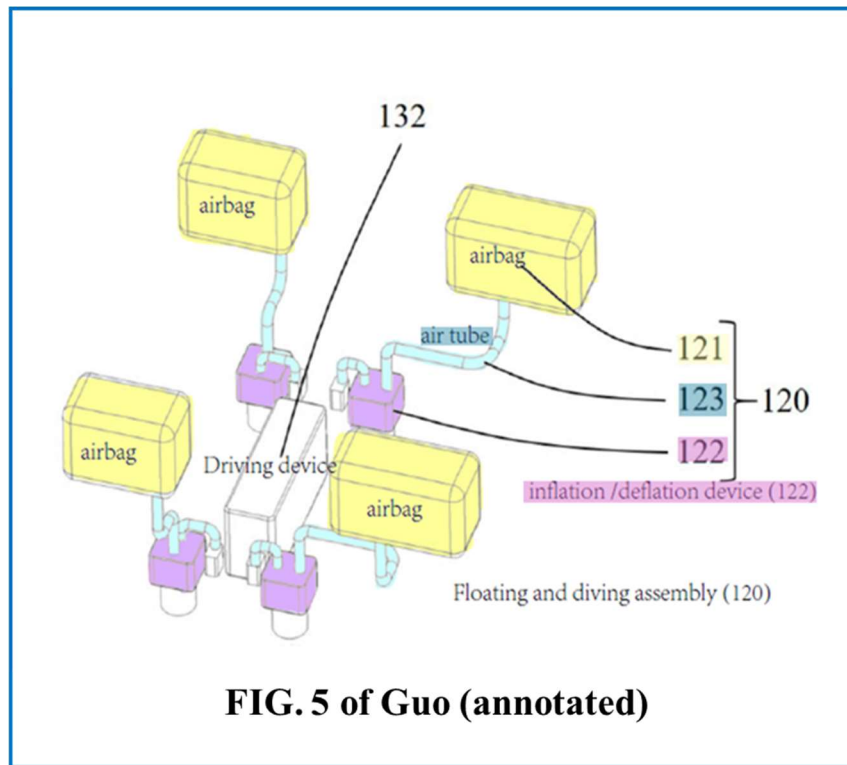
Zhang also discloses **processor-driven navigation**, where the processor receives a target task (via user input, schedule, or environmental analysis), computes an **adjustment parameter** including route information, and commands the robot to locate, climb, and clean a pool wall or slope. EX1009, 7:14-17, 8:37-49, 11:47-49, 13:23-33, 16:42–17:17, 17:28–55.



C. Guo (EX1010)

Guo was published on March 22, 2024, and is prior art under 35 U.S.C. §102(a)(1).

Guo discloses a pool-cleaning robot equipped with a **buoyancy-control system** that enables **autonomous floating and sinking**. EX1010, Abstract, ¶¶[0019], [0056]. The buoyancy system uses **pumps and valves** to transfer gas between inflatable **airbags** and a sealed cabin, thereby controlling the robot's buoyant state. EX1010, ¶¶[0008]–[0009], [0033]–[0034]; FIG5. Guo further teaches several coordinated pump–valve configurations for the buoyancy-control system. EX1010, ¶¶[0041]–[0050].

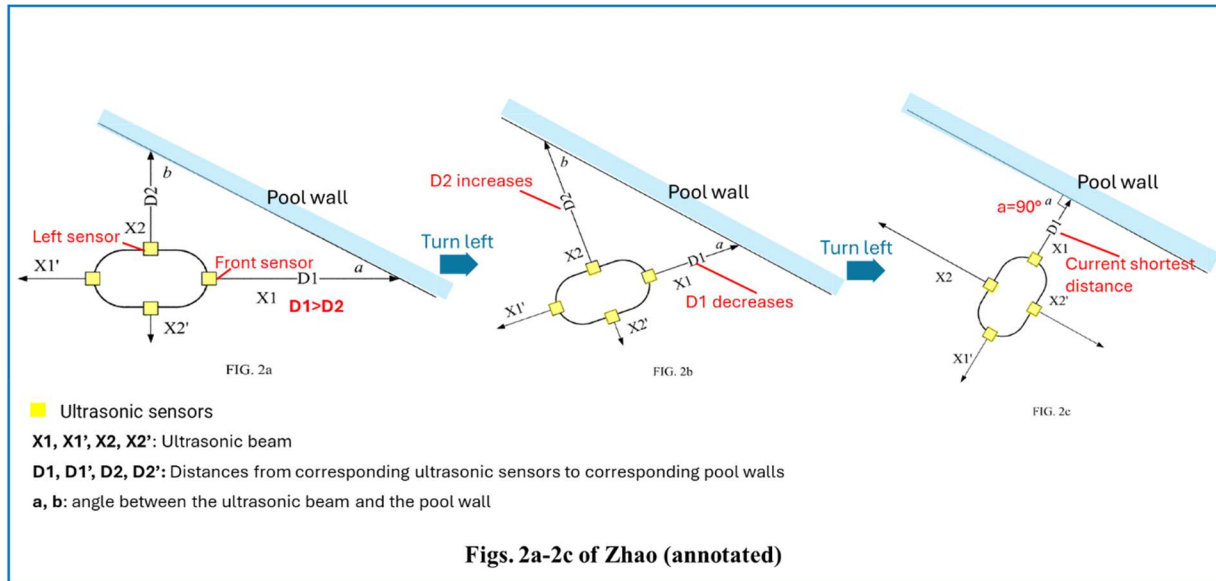


D. Zhao (EX1012)

Zhao was issued October 31, 2023, and is prior art under 35 U.S.C. §102(a)(1).

Zhao discloses an **automatically docking** pool-cleaning robot that uses a **sensor suite** to detect and approach the nearest wall, align itself, and surface for docking or retrieval. EX1012, Abstract, 1:38–42; 2:63–65; 4:6–25; 5:3–49; 7:56–8:5. To accomplish this, Zhao teaches positioning **multiple ultrasonic sensors** on the front, rear, left, and right sides of the robot to measure respective distances to nearby pool walls. EX1012, 4:12–13, 4:49–51. Upon receiving a **docking instruction**, the robot compares these measurements to identify the closest wall, adjusts its orientation by varying motor speeds if necessary, and advances toward

the selected wall. EX1012, 1:38–42; 4:6–17; 4:33–40; 4:49–51; 4:62–65; 5:3–49; 6:55–57; FIGS. 2a–2d.



After contacting the wall, Zhao's robot climbs vertically to the waterline while a **gyroscope** monitors posture, a **counter** tracks motion, and **control logic** maintains balance at or near the surface. EX1012, 4:18–25; 6:16–32. Zhao further discloses a user interface showing proximity to the waterline and the completion degree of the docking sequence. EX1012, 8:11–42, Figs. 6a–6c.

E. Owen (EX1013)

Owen was published September 20, 2007, and is prior art under 35 U.S.C. §102(a)(1).

Owen teaches automatic, timer-based shutoff for pumps inflating bladders. EX1013, 1:10–14. The pump runs for a preset interval and then turns off

automatically to prevent overinflation and motor damage when unattended. EX1013, 1:19-23, 1:30-2:15. Owen implements this with a timer circuit on a board or chip that drives the motor for a predetermined time and then de-energizes the pump. EX1013, 3:19-28. Owen explains that the durations may be programmed for different inflation levels or bladder sizes. EX1013, 3:29-4:6.

VII. SPECIFIC GROUNDS FOR PETITION

Pursuant to Rule 42.204(b)(4)-(5), the following sections (as supported by EX1003, ¶¶55-722) detail grounds of unpatentability for claims 1-19 of the '196 Patent.

A. Ground 1: Claims 1-7, 9-11, and 13-19 are obvious under §103 over Wang in view of Zhao and Owen

1. Motivation to Combine

A POSITA would have been motivated to combine Wang, Zhao, and Owen to achieve a more autonomous, reliable, and efficient pool-cleaning robot. EX1003, ¶¶261–263, 270–289, 322, 345–346.

a. Motivation to Combine Wang and Zhao

Both Wang and Zhao address autonomous underwater pool-cleaning robots capable of operating along pool walls to improve cleaning efficiency. EX1003, ¶261. Each aims to enhance navigation and wall-cleaning performance by enabling the

robot to locate, approach, and climb walls for cleaning. EX1012, 4:62–65; EX1005, ¶¶[0068]–[0070], [0138]–[0139]; EX1003, ¶261.

Zhao provides the distance-sensing and wall-finding control logic, while Wang provides the multi-state motion control system and mechanical structure that allows wall climbing once contact is established. EX1003, ¶261. Zhao’s distance-based detection and Wang’s multi-state control are directly compatible and complementary: Zhao’s sensors supply real-time wall-distance data for approach and orientation, while Wang’s motion logic enables engagement and climbing. EX1003, ¶262. Combining these teachings would predictably yield a unified, sensor-driven control architecture in which Zhao provides feedback for wall detection and Wang provides actuation for wall climbing. *Id.*

A POSITA implementing Zhao’s system would find it obvious and advantageous to incorporate Wang’s three-state motion control (bottom cleaning, wall cleaning, surface cleaning) to achieve complete cleaning coverage. EX1003, ¶263. Conversely, a POSITA implementing Wang’s design would naturally adopt Zhao’s ultrasonic wall-finding logic to automate the initiation of wall climbing. *Id.* Both combinations produce predictable benefits—greater autonomy, stability, and cleaning efficiency. *Id.*

A POSITA would also have been motivated to combine Zhao’s posture-based triggering with Wang’s waterline-detection and buoyancy-control mechanisms,

since both address the same control problem—automated, sensor-driven coordination between posture change detection and buoyancy adjustment. EX1003, ¶322. Combining these systems would yield a more efficient, fully automated control process: upon detecting a change to a vertical posture, the controller activates waterline monitoring and initiates buoyancy adjustment, seamlessly transitioning the robot from bottom cleaning to wall climbing and then to surface cleaning. *Id.*

Similarly, a POSITA would have found it obvious to integrate Zhao’s distance-sensing and mapping functions with Wang’s route-planning logic to enable the robot to detect its current position, determine the nearest wall or slope, and autonomously navigate toward that surface for cleaning. EX1003, ¶345. This integration would have been straightforward and predictable, resulting in a more efficient, sensor-driven navigation system fully aligned with the control objectives of both references. EX1003, ¶346.

b. Motivation to Combine Wang and Owen

Wang teaches that when the robot reaches the surface and the air inlet is exposed to air, the processor activates the pump to increase gas volume, switching the device from submerged to floating mode. EX1003, ¶270. Wang further explains that a **gas-volume threshold** is established to maintain a balanced buoyant force. EX1005, ¶¶[0099], [0117], [0122]; EX1003, ¶270. A POSITA would understand

that this threshold inherently requires the pump to stop after a predetermined time to prevent overinflation or airbag damage. *Id.*

Dr. Cowan explains that for a pump operating at a roughly constant flow rate (Q), the inflated volume (V) increases **linearly** with time (t) — $V \approx Q \times t$ — until an asymptotic volume. EX1003, ¶¶271–272. Given this relationship, a POSITA would select a **predetermined inflation time** that achieves the desired buoyancy threshold while remaining within structural limits, thereby providing a safe and consistent inflation margin. EX1003, ¶273.

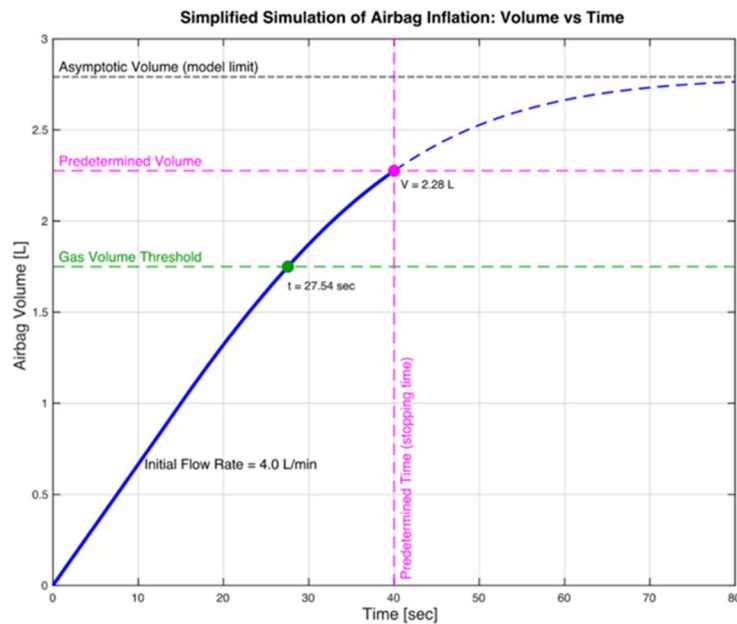


Fig. 1 of EX1021

Figure 1 (EX1021) illustrates this relationship: a pump delivering 4.0 L/min reaches the **Gas Volume Threshold** (1.75 L) in ~27.5 seconds, while a 40-second stopping time yields safe, stable inflation below capacity. EX1003, ¶¶274–275. Thus,

a POSITA would recognize that Wang’s **gas-volume threshold** corresponds to a **predetermined-time inflation** control to prevent overfilling and maintain safety. EX1003, ¶276.

By 2024, timer-based control of pumps and motors was standard practice in industrial automation. EX1003, ¶¶277–279; EX1022, *Programmable Logic Controllers*, 6th Edition (“timers ... a motor or a pump might need to be controlled to operate for a particular interval of time”). A POSITA would therefore have been motivated to implement a **timer-controlled cutoff**, as taught by Owen, to automate and improve Wang’s buoyancy regulation. EX1003, ¶280.

Owen teaches exactly this control scheme: a timer circuit that energizes a pump for a **predetermined time** and then automatically shuts it off, preventing overinflation or motor damage. EX1013, 3:19–28, 4:7–10, 4:20–26; EX1003, ¶280.

Integrating Owen’s timer circuit into Wang’s buoyancy-control framework would have been a routine substitution of known control methods, achieving the same predictable result—safe, consistent buoyancy, reduced cost and complexity, and protection against overinflation. EX1003, ¶¶281–286. As Dr. Cowan explains, this integration would have been expected to work reliably because timer-based pump control was a mature, deterministic technology used across pneumatic and fluid systems. EX1003, ¶¶287–288. Accordingly, a POSITA would have been motivated to combine Wang and Owen to achieve predictable, improved buoyancy

control—using Owen’s timer-based cutoff to regulate Wang’s inflation cycle and prevent overinflation. EX1003, ¶289.

c. Predictable Results of the Combination

The combination of Wang, Zhao, and Owen represents a predictable, complementary integration of well-known systems. EX1003, ¶¶263, 280, 285-289, 321-322, 345-346. Zhao provides distance sensing, wall-finding, and posture-triggered control; Wang provides multi-state operation and buoyancy management; and Owen provides reliable, timer-based control of inflation duration. EX1003, ¶¶254-257; 260-263, 266-268, 280-282, 315-320, 335-344.

A POSITA would have viewed this combination as a routine optimization—using each reference’s established elements for their known purposes—to achieve a fully automated, sensor-driven, and self-regulating pool-cleaning robot capable of detecting walls, climbing and cleaning surfaces, and autonomously managing buoyancy transitions without overinflation or instability. EX1003, ¶¶263, 280, 285-289, 321-322, 345-346.

d. Owen Is Analogous Art

Owen is analogous art to both Wang and the ’196 Patent because it (1) falls within the same field of endeavor and (2) is reasonably pertinent to the problem the inventors sought to solve. EX1003, ¶¶290–291. A POSITA would have logically

looked to Owen when addressing the same air-inflation control problem identified in the '196 Patent. *Id.*

Although Owen's embodiment concerns an inflatable mattress, it explicitly applies to "an inflatable mattress **or other inflatable object**," confirming a broader technical field encompassing control of air pumps, bladders, and automatic shutoff mechanisms. EX1013, 3:1–5; EX1003, ¶292. These are the same core components and functions employed in buoyancy-control systems of pool-cleaning robots. EX1003, ¶292. Each system—Owen, Wang, and the '196 Patent—(1) uses an air pump to deliver controlled gas volume, (2) relies on a flexible bladder or cavity to adjust state (inflation/buoyancy), and (3) includes a control mechanism to terminate inflation safely and prevent overpressure. *Id.* As recognized in *In re Bigio*, 381 F.3d 1320, 1327 (Fed. Cir. 2004), products can be analogous where they share the same technical principles even if they serve different end uses.

Dr. Cowan opines that the difference in application here—household bedding versus aquatic robotics—is superficial to a POSITA. EX1003, ¶293. Both technologies solve the same underlying control problem: how to fill a compliant airbag to a desired volume. *Id.*

Owen directly addresses this issue, teaching "a timer that operates the pump after activation for a set period of time before automatically shutting off the pump." EX1013, Abstract; EX1003, ¶296. A POSITA designing a buoyancy-control system

would face the same design challenge—determining how long to operate a pump to achieve safe, consistent inflation—and would recognize Owen’s timer-controlled shutoff as a proven solution, regardless of the operating medium. EX1003, ¶297.

A POSITA addressing Wang’s buoyancy-control problem would naturally consult adjacent pneumatic-inflation technologies—air mattresses, airbags, or pneumatic bladders—where the same safety and control issues had long been solved. EX1003, ¶298. As Dr. Cowan states, Owen “would have commended itself to an inventor’s attention in considering his problem,” offering a tested, reliable solution—timer-controlled inflation termination—to the very issue addressed by Wang. EX1003, ¶¶299-300.

From a control-systems perspective, both use simple safety controllers that terminate inflation based on time or volume. EX1003, ¶301. The distinction lies only in application domain, not in the technology or control logic. *Id.*

Accordingly, Owen’s timer-controlled inflation shutoff is directly transferable to Wang’s buoyancy-control system and the ’196 Patent’s sinking and floating control unit. EX1003, ¶302. A POSITA would therefore have regarded Owen as analogous art and a logical reference to combine when developing or evaluating the claimed buoyancy-control architecture. EX1003, ¶¶209-302.

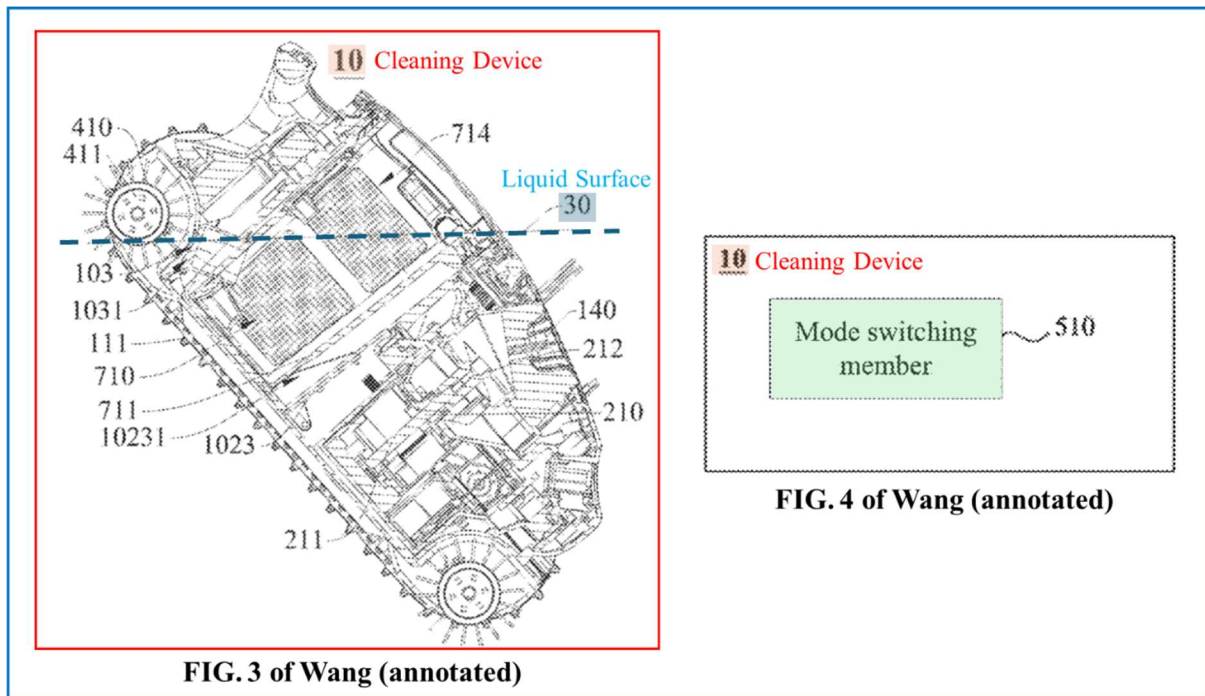
2. Claim 1

a. Element [1pre]

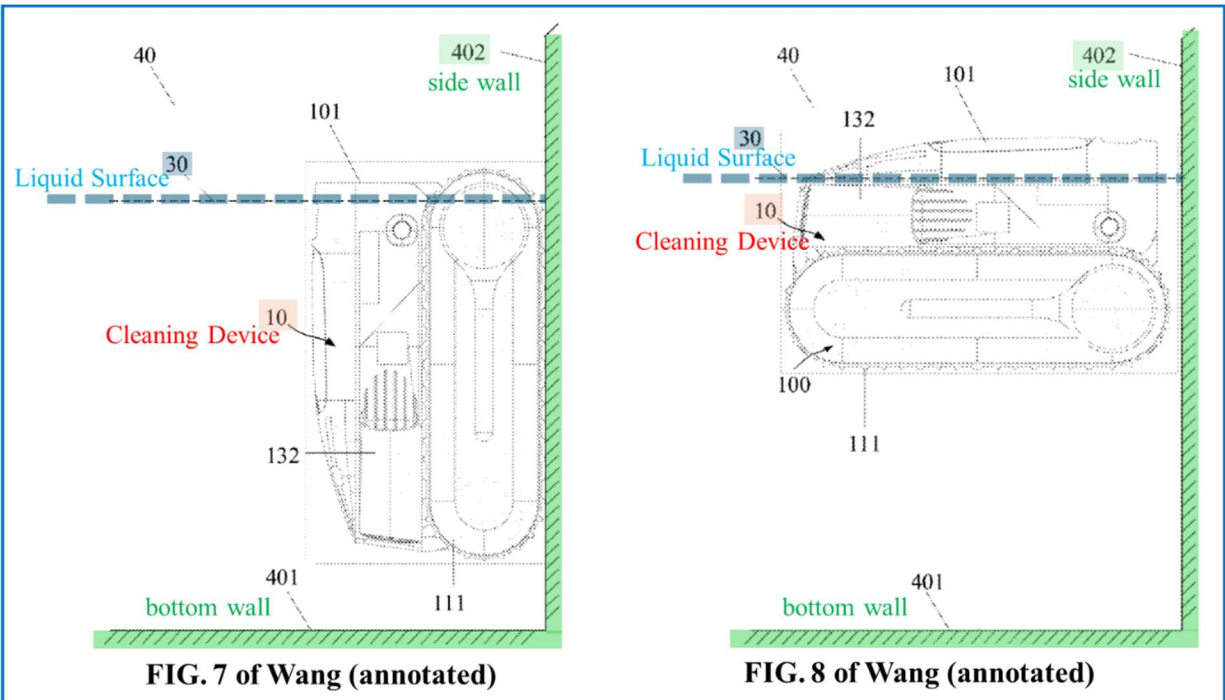
Wang discloses a controllable sinking and floating swimming pool robot. EX1005, ¶[0064]; EX1003, ¶230.

b. Element [1a]

Wang discloses a **mode switching member** that controls the robotic cleaning device, allowing it to clean both on and beneath the water surface. EX1005, ¶¶[0067], [0098]-[0099], [0117]-[0118]; EX1003, ¶¶231-236.



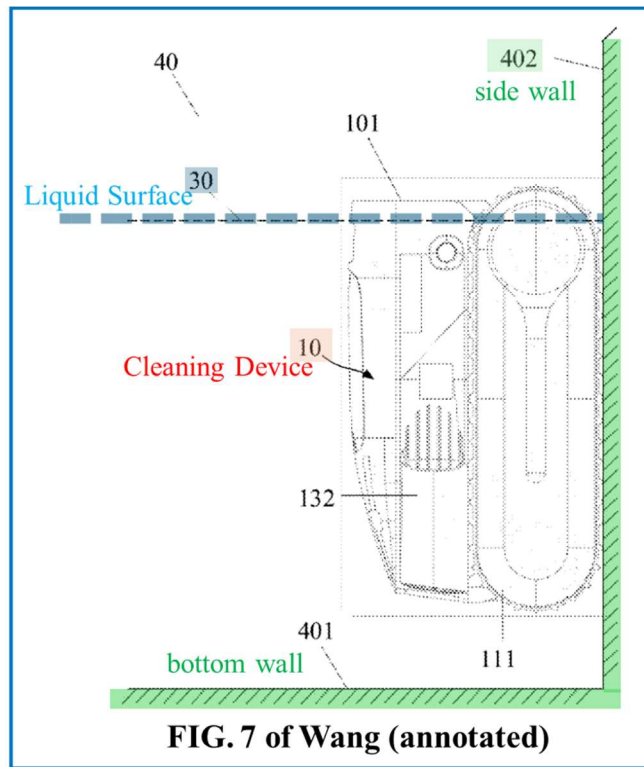
FIGS. 7 and 8 of Wang show the device cleaning the side wall and floating on the water surface. EX1003, ¶236.



c. Element [1b]

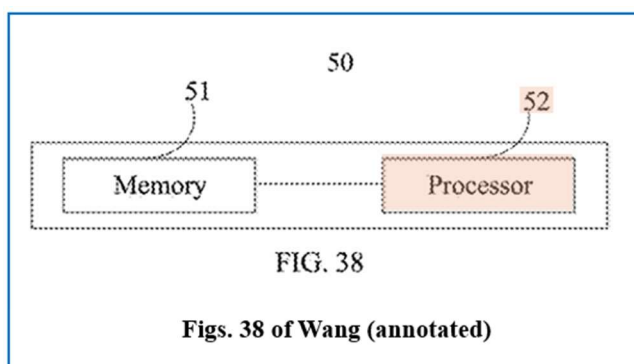
Wang discloses a **first sensor** that detects the robot's **vertical position** (depth) relative to the waterline, and a **second sensor** that detects whether the air inlet is above the waterline. EX1005, ¶[0113], [0115]; EX1003, ¶¶237, 239.

Wang discloses a **processor** receiving **position information** from the first sensor and adjusting buoyancy in response to a preset condition that the position is higher than a preset height. EX1005, ¶[0114]; EX1003, ¶238.

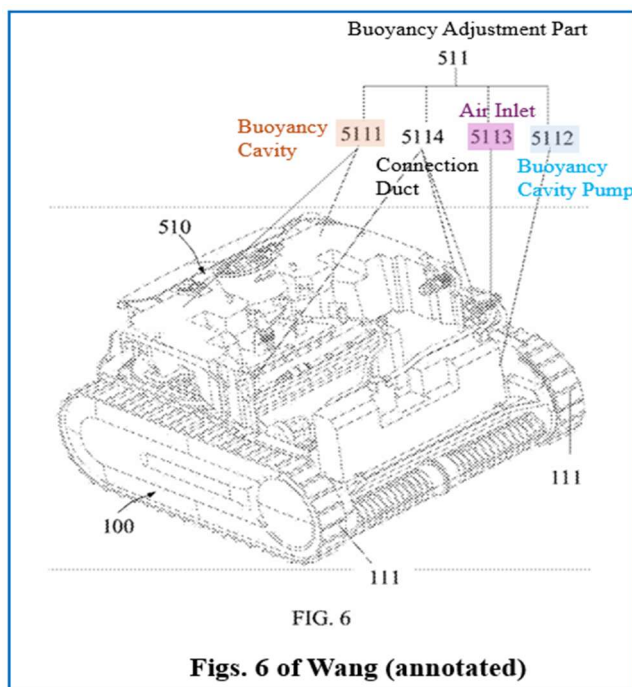


d. Element [1c]

Wang discloses a **processor** that controls the **buoyancy adjustment part** of the **mode-switching member**, increasing the volume of gas in the buoyancy cavity to enable the cleaning robot to float. EX1005, ¶[0114] (“the cleaning device 10 may further include a **processor 52** ... to control various components ...”), FIG. 38; EX1003, ¶¶240-243.



Wang's processor obtains data from sensors, determines when the cleaning device meets preset conditions, and controls the transition of the pool-cleaning robot between submerged and floating states. EX1005, ¶¶[0117]-[0118]; EX1003, ¶¶241-242.



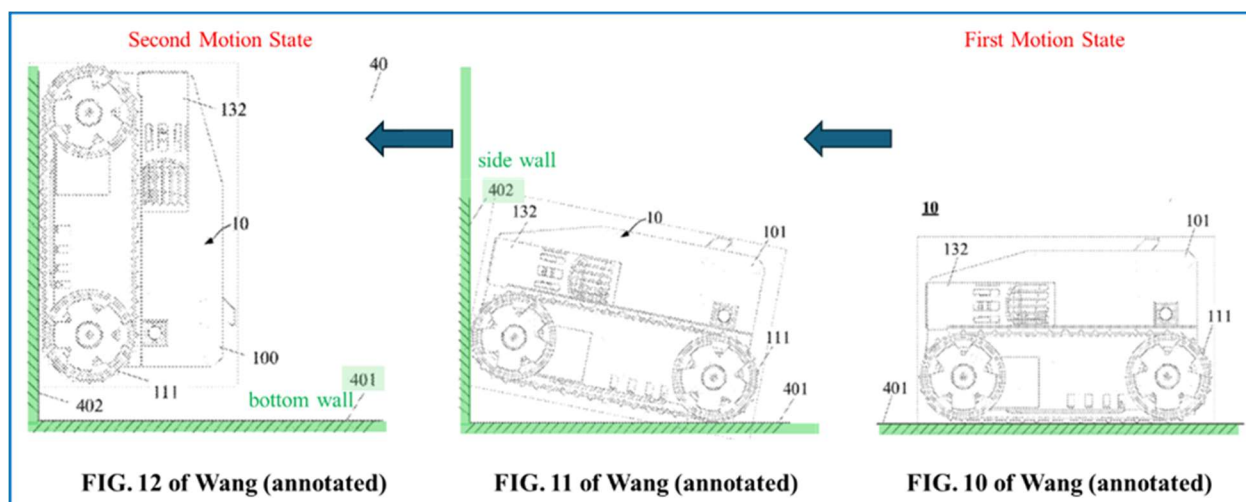
e. Element [1d]

Wang, alone or in combination with Zhao, discloses this limitation. EX1003, ¶¶244-263.

Wang discloses that the pool-cleaning robot operates based on **user input** or **scheduled cleaning tasks**. EX1005, ¶¶[0182]-[0184]; EX1003, ¶¶245, 247. The task may specify cleaning the pool bottom or sidewall and may be user-selected or pre-scheduled. EX1005, ¶¶[0183]-[0184]; EX1003, ¶246.

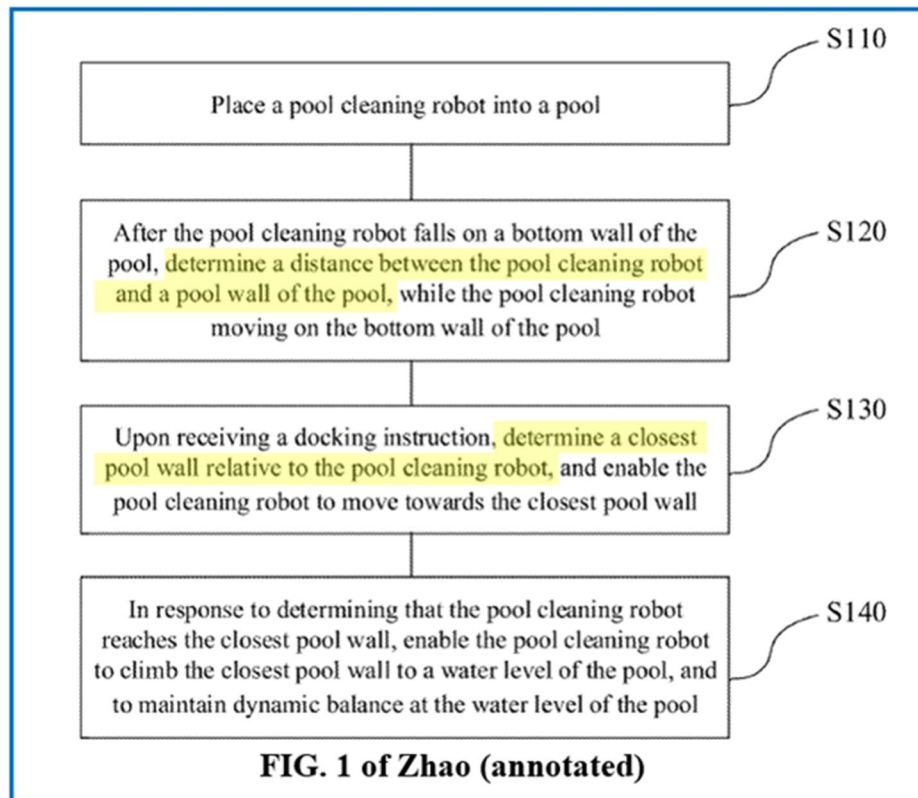
After receiving the task, Wang's processor determines **route and movement parameters** needed to complete the task, including **adjustment parameters** for the movement mechanism. EX1005, ¶[0185]; EX1003, ¶¶248-249. The adjustment parameters may include route information and a target-task position, both dependent on the robot's starting and current positions. EX1005, ¶¶ [0187]-[0188]; EX1003, ¶¶250-251.

A POSITA would understand that Wang's disclosed control logic inherently enables the processor to **plan and direct movement** based on the operational task—e.g., to travel from its current location to a sidewall when the task is to clean the pool wall. EX1003, ¶¶252-253. Wang further identifies multiple motion states tied to distinct cleaning modes: a **first motion state** for bottom cleaning, a **second motion state** for wall cleaning, and a **third motion state** for surface cleaning. EX1005, ¶¶[0068]-[0070], FIGS. 10-12; EX1003, ¶¶254-255.



A POSITA would further understand that Wang teaches both the **control-level behavior** (path planning and task-based actuation) and the **mechanical implementation** (drive wheels/track system) enabling the robot to locate and climb a wall based on user input. EX1005, ¶¶[0138]-[0139]; EX1003, ¶255-257.

To the extent that Wang's disclosure is insufficient, Zhao teaches them. EX1003, ¶258.



Zhao discloses **sensors** that allow the **processor** to control the robot to locate the nearest sidewall based on user instructions. EX1012, FIG. 1, 4:6-17, 4:62-5:2 (“when the pool cleaning robot receives the **docking instruction**, the pool cleaning robot stops moving, **determines the closest pool wall** ..., and moves towards the closest pool wall.”); EX1003, ¶¶259-260.

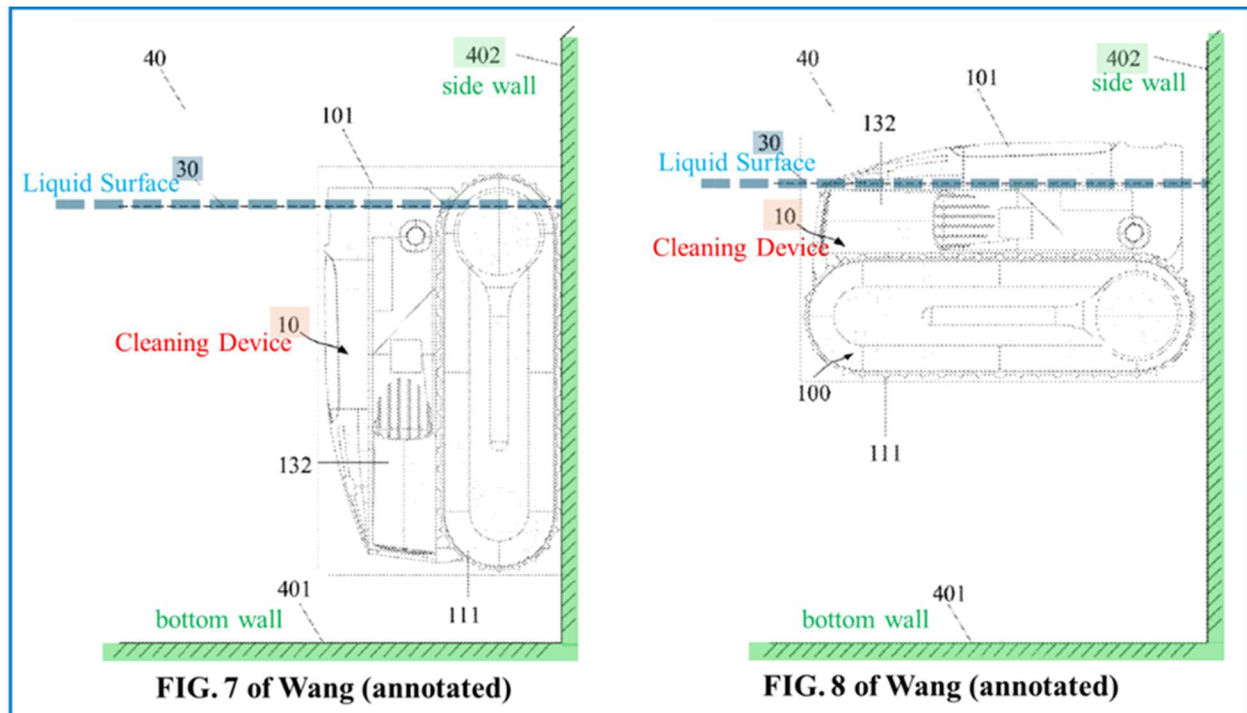
f. Element [1e]

Wang discloses this limitation. EX1003, ¶¶264-265. Wang describes how the **processor** obtains **position data** of the cleaning device from a **first sensor** or a **second sensor** when transitioning between submerged and floating positions. EX1005, ¶[0114]; EX1003, ¶¶264-265. The processor uses this sensor data to

determine whether the cleaning device meets a preset condition—such as being above a **preset height** or whether the air inlet is **above water**—and based on that determination, controls the buoyancy adjustment part accordingly. *Id.*

g. Element [1f]

Wang discloses this limitation. EX1003, ¶¶266-268. Wang teaches that when the **detected depth** is shallower than a **preset height**, the **processor** activates pump 5112 to inject air into cavity 5111, thereby raising inlet 5113 above the water surface and causing the cleaning device to float. EX1005, ¶[0114], FIGs. 7, 8; EX1003, ¶266.



Wang further discloses the **pneumatic mechanism** by which buoyancy is actively increased to achieve this floating state. The **buoyancy-adjustment system** includes a buoyancy-cavity pump (5112) and a one-way valve positioned at the air

inlet (5113). During operation, the pump forces air into cavity 5111, increasing internal volume and buoyant force so the robot floats. EX1005, ¶[0109]; EX1003, ¶267. A POSITA would understand that energizing the pump opens the one-way valve to admit air while preventing backflow, allowing the cavity to fill with gas and increase buoyancy. EX1003, ¶267.

Wang states that adjusting the gas within the buoyancy cavity (511) “modifies a buoyancy force applied to the cleaning device,” confirming that the pump-and-valve system provides **active buoyancy control** for transitioning into the floating working state. EX1005, ¶[0120]; EX1003, ¶268.

h. Element [1g]

Wang, alone or in combination with Owen, discloses this limitation. EX1003, ¶¶269-302. Wang teaches that when the robot is exposed to air, the processor controls the pump to increase the gas volume in the cavity, switching the device from a submerged to a floating state; additionally, a **gas volume threshold** is established to maintain a balanced vertical force. EX1005, ¶¶[0099], [0117], [0122]; EX1003, ¶270. A POSITA would understand that this “gas volume threshold” inherently requires the pump to stop operating **after a predetermined time** to prevent overinflation or damage to the buoyancy cavity. EX1003, ¶270.

As explained above and illustrated in FIG. 1 of EX1021, due to the $V \approx Q \times t$ relationship, a POSITA would readily select a **predetermined inflation time** that ensures the airbag exceeds the minimum buoyancy requirement (the “**Gas Volume Threshold**”) while remaining below its pressure limit. EX1003, ¶271-275. A POSITA would thus recognize that Wang’s “gas-volume threshold” inherently corresponds to a **predetermined-time** inflation control to prevent overfilling or mechanical failure. EX1003, ¶276.

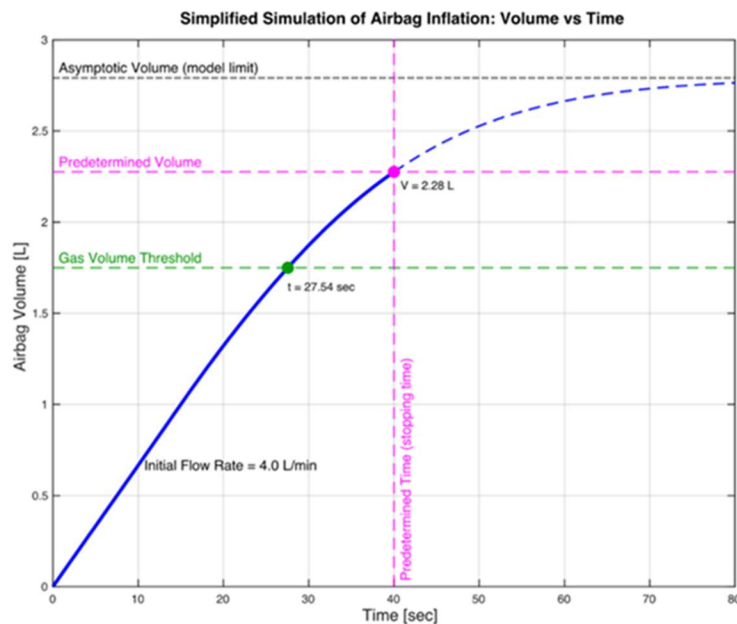


Fig. 1 of EX1021

Accordingly, a POSITA would have been motivated to implement this well-known timer-based shutoff, as taught by Owen, to automate and improve Wang’s buoyancy control. EX1003, ¶277-280. Owen discloses timer circuits that run a pump for a **predetermined time** and then automatically shut it off—preventing

overinflation or motor damage. EX1013, 3:19-28 (“In one embodiment, a circuit board (not shown), or an integrated chip (not shown) that serves as a **timer** is mounted to such a circuit board, is provided to control the pump. The circuit board or chip is programmed to allow the pump to run **for a set period of time** after it is activated.”), 4:7-10, 4:20-26; EX1003, ¶280, 282.

3. Claim 2

a. Element [2a]

Wang discloses a posture detection unit that includes a **gyroscope sensor** configured to detect the rotation angle or attitude of the pool-cleaning robot. EX1005, ¶[0256]; EX1003, ¶303. Wang further discloses an **attitude sensor** that cooperates with the processor to maintain the robot’s attitude stability during operating state switching. EX1005, ¶[0120]; EX1003, ¶304.

b. Element [2b]

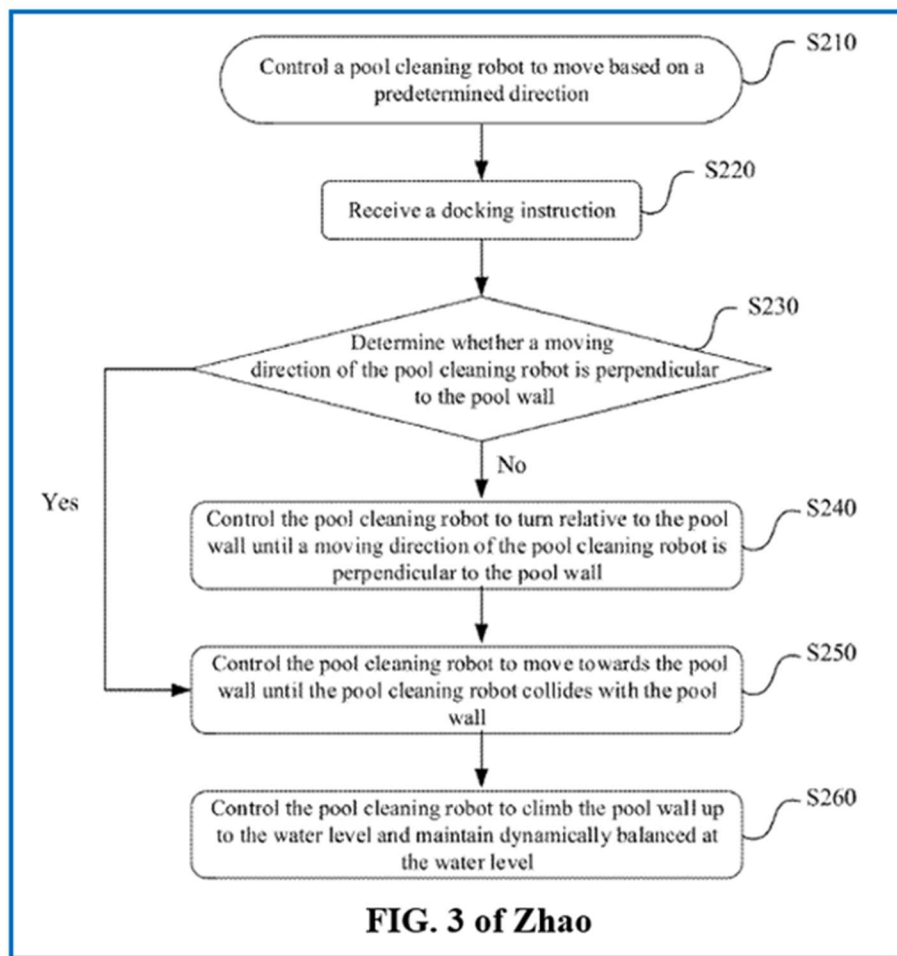
Wang, alone or in view of Zhao, discloses this limitation. EX1003, ¶¶305-322. The ’196 Patent describes the “first predetermined condition” as a **posture change**. EX1001, 9:37-40; EX1003, ¶306. Wang teaches that the robot includes a **gyroscope** for determining its **real-time posture** and **depth** in the pool, where the control system defines multiple motion states: a **first motion state** (bottom cleaning), a **second motion state** (wall cleaning), and a **third motion state** (surface cleaning). EX1005, ¶¶[0068]-[0070], [0138]-[0139]; EX1003, ¶307.

Wang's processor monitors the gyroscope output to detect when the robot **changes orientation** from a horizontal to a vertical position, and in response, switches to the wall-cleaning mode—the second motion state. EX1005, ¶[0068]; EX1003, ¶308. A POSITA would understand this control logic as using posture feedback to determine when the robot transitions from bottom cleaning to wall cleaning when the “first predetermined condition” is satisfied. EX1003, ¶309.

Once in wall-cleaning mode, Wang discloses that the **first sensor** (e.g., ultrasonic or pressure) begins detecting the robot's positional relationship to the waterline. EX1005, ¶[0114], FIGS. 7-8; EX1003, ¶310. When the gyroscope confirms that the robot is substantially parallel to the wall, the controller activates the waterline-detection function. While ascending, the robot continues monitoring its position relative to the surface; when the air inlet becomes exposed to air, the buoyancy pump increases gas volume in the cavity to complete the transition to the floating (**surface-cleaning**) state. EX1005, ¶[0120]; EX1003, ¶311. Wang therefore teaches sequential control: (1) posture detection triggers a change to wall-cleaning mode, (2) the system begins waterline detection, and (3) upon detecting exposure of the inlet, the buoyancy pump activates to enter the floating state. EX1005, ¶¶[0113]-[0115]; EX1003, ¶¶312-314.

Zhao independently teaches a posture-based trigger of the same type. EX1003, ¶¶315-319. Zhao's robot determines whether it is on the bottom or sidewall using

gyroscope data to detect transition into wall-climbing mode. EX1012, 7:1-7; EX1003, ¶315. When the robot determines it has changed from the bottom to the wall—i.e., when the posture meets the first predetermined condition—Zhao initiates its climbing and docking sequence, which necessarily includes detecting its positional relationship relative to the waterline. EX1012, 6:42-60, FIG. 3; EX1003, ¶316-317. During ascent, Zhao’s gyroscope and counter record angle and height, tracking the robot’s vertical position, and the system monitors the distance to the water level. EX1012, 8:11-42; EX1003, ¶¶318-319.



Thus, a POSITA would understand that Zhao teaches this limitation. EX1003, ¶320.

4. Claim 3

Wang discloses a **task-acquisition module** that receives a cleaning task from a **user**, including tasks for cleaning water surfaces, underwater areas, the bottom, or walls. EX1005, ¶¶[0182]-[0184]; EX1003, ¶¶323-325.

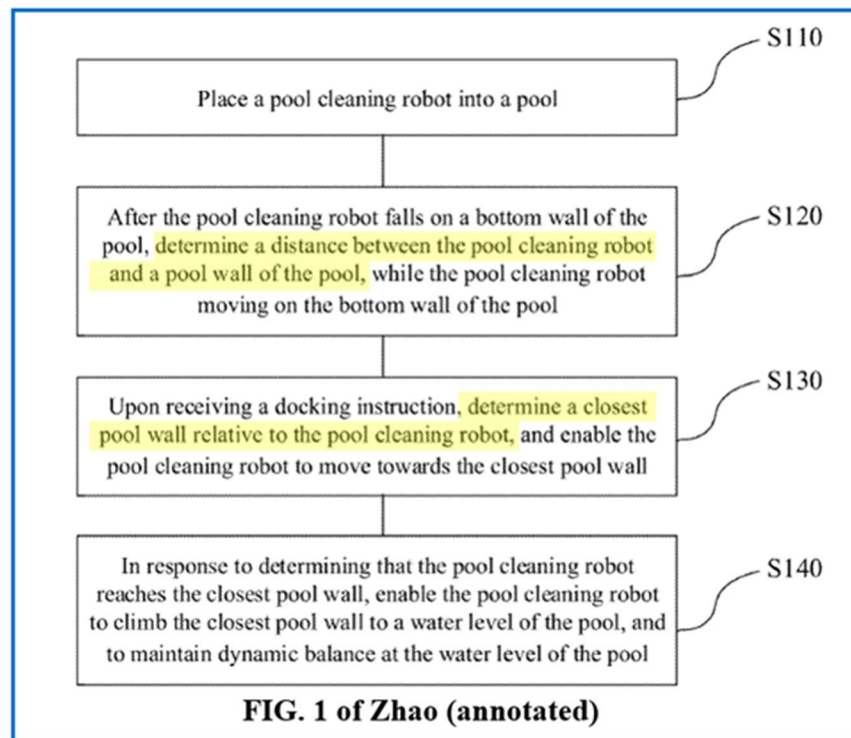
5. Claim 4

Wang, alone or in combination with Zhao, discloses this limitation. EX1003, ¶¶326-346. Wang discloses a controllable robot with a **position-sensing unit** and a **controller** that plans a route from the sensed current position to a target task position and drives the robot along that path; for example, the robot may switch to a motion state in which it travels along the pool wall while executing the planned route toward the task location. EX1005, ¶[0068], FIGS. 7, 12; EX1003, ¶327.

Wang further teaches that the moving mechanism is adjusted based on both the target task and the current position of the device, the position being determined using the **first sensor**. EX1005, ¶¶[0185]-[0186]; EX1003, ¶¶328-329. The **adjustment parameter** may include route information linking the current position to the task position, and the controller then directs the motion components based on that parameter. EX1005, ¶¶[0187]-[0189]; EX1003, ¶¶330-332.

Accordingly, Wang describes control logic enabling the processor to (1) sense the robot's position through onboard sensors, (2) plan a route to a target task region (e.g., wall or slope), and (3) drive the robot along that route. EX1003, ¶333. A POSITA would understand that to initiate Wang's **second motion state** (wall-cleaning mode), the controller must determine which wall is nearest and then navigate toward it using positional or distance data. EX1005, ¶¶[0068]-[0070]; EX1003, ¶333.

To the extent Wang does not explicitly reference a “nearest wall,” Zhao complements Wang by providing the specific **distance-sensing** and **mapping** functions that identify and approach the closest wall. EX1012, FIG. 1; EX1003, ¶334.



Zhao teaches **ultrasonic sensors** that measure wall distances or use **3D-map** information to locate the robot and determine the closest pool wall. EX1012, 4:6-17; EX1003, ¶¶335-336. Zhao also describes gyroscopes and counters to calculate travel distance and orientation, and the use of map data to determine the robot's position within the pool. EX1012, FIG1, 1:38-42, 4:18-25, 4:33-40, 4:62-65, 6:33-37, 7:1-7, 7:11-21; EX1003, ¶¶337-344.

6. Claim 5

Wang discloses a **second sensor** that detects whether the air inlet is exposed to the air and at least a part of the robot has come out of the water. EX1005, ¶[0115]; EX1003, ¶347.

7. Claim 6

Wang discloses that the cleaning device includes a **first sensor** configured to determine the robot's **vertical position (depth)** within the pool. EX1005, ¶[0113]; EX1003, ¶348. The first sensor—implemented as a pressure, ultrasonic, or optical sensor—detects the robot's current depth and transmits this positional data to the processor. *Id.* Wang further explains that the first sensor cooperates with the mode-switching member to allow the robot to maintain or move at a predetermined depth. *Id.* Wang also teaches that when the robot transitions from an underwater to a surface position, the processor uses real-time data from the first sensor to determine whether a preset condition is satisfied—such as the robot's depth being shallower than a

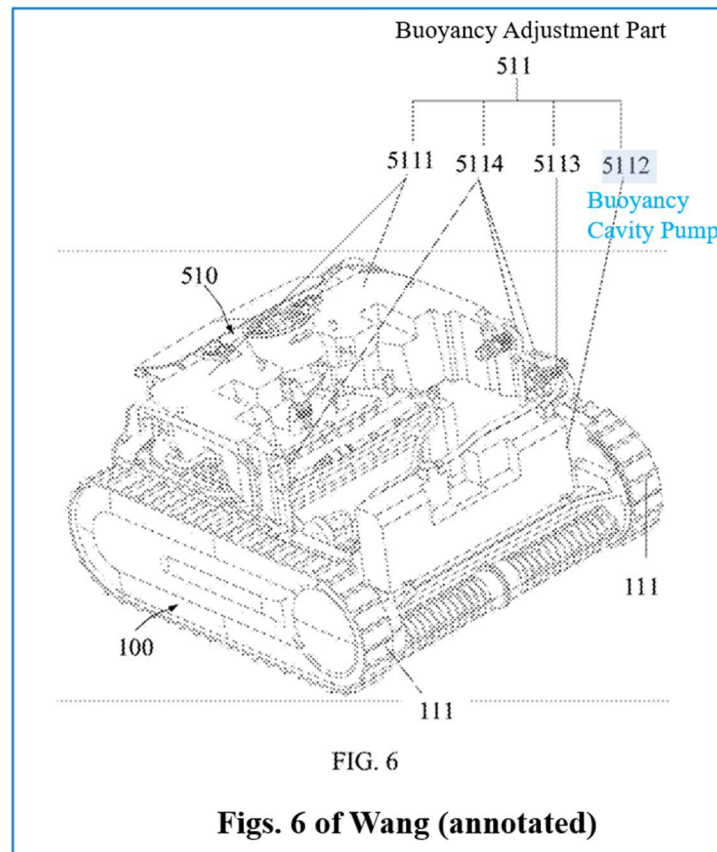
preset height. EX1005, ¶[0114]; EX1003, ¶349. When that condition is met, the processor determines that the air inlet (5113) of the buoyancy cavity is above the water surface and activates the buoyancy pump to drain liquid and admit air. *Id.*

A POSITA would understand this control logic corresponds to the claimed proximity waterline detection function; specifically, the first sensor continuously monitors the robot's vertical position, and when it detects that the robot has ascended to within a predefined threshold distance of the waterline (i.e., a height greater than a preset depth), the processor recognizes that proximity condition and triggers the buoyancy-adjustment sequence. EX1003, ¶350.

8. Claim 7

a. Element [7a]

Wang discloses that the **buoyancy adjustment assembly**—part of the mode-switching member—includes a buoyancy cavity pump (5112) serving as an inflation and deflation subunit, and a one-way valve functioning as a switch subunit. EX1005, ¶[0109], FIG. 6; EX1003, ¶¶351-352. The buoyancy cavity pump is controlled to inject or extract air from the buoyancy cavity, regulating the robot's buoyancy and causing it to float or sink. *Id.*



The one-way valve positioned at the air inlet automatically closes when the pump stops, preventing water from backflowing into the cavity and thereby locking the robot at its preset buoyancy level. *Id.* Wang also discloses an alternative configuration achieving the same buoyancy-control functionality. EX1005, ¶[0111]; EX1003, ¶353.

b. Element [7b]

Wang discloses a **second sensor** (the outlet water detection subunit) that monitors whether the **air inlet** is above the pool water surface. EX1005, ¶[0115]. “When the detection result indicates that the **air inlet 5113 is exposed to the air**,

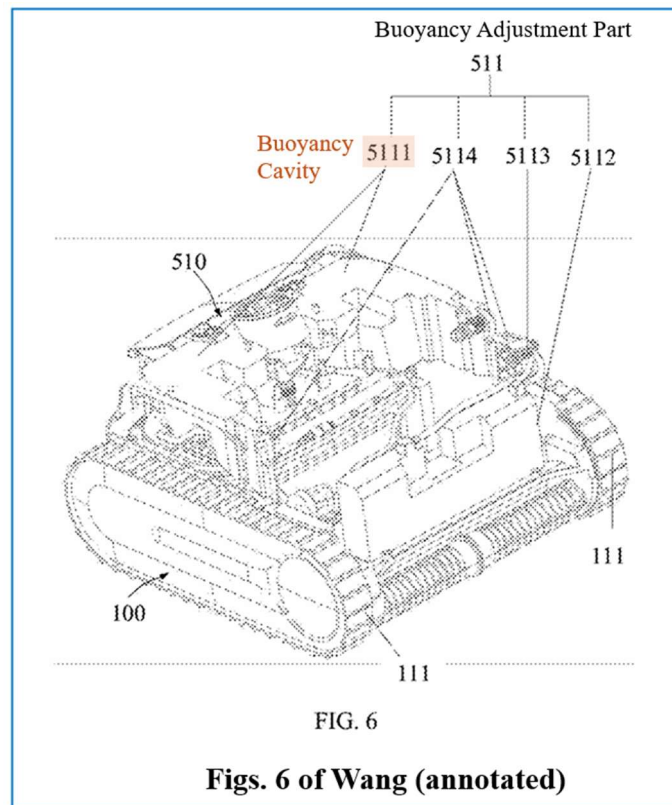
the buoyancy adjustment part is controlled to **increase the volume of the gas** in the buoyancy cavity 5111 to switch the cleaning device 10 from the position under the liquid surface 30 to the position on the liquid surface 30.” EX1005, ¶[0117]; EX1003, ¶356.

Thus, Wang teaches an **outlet water detection subunit** that, upon sensing that part of the robot has **emerged from the water**, triggers the inflation–deflation subunit to begin drawing air while the switch subunit is opened. EX1005, ¶¶[0112], [0115], [0117], [0118], [0120]; EX1003, ¶¶354-359.

9. Claim 9

a. Element [9a]

Wang discloses a **buoyancy-adjustment assembly** (511) including a **buoyancy cavity** (5111), formed from **flexible materials** such as rubber and the like. EX1005, ¶[0099]; EX1003, ¶360. A POSITA would recognize that Wang’s **buoyancy cavity** performs the same structural and functional role as the claimed airbag subunit. *Id.*



Wang further teaches that the buoyancy cavity is connected to the atmosphere through the buoyancy-cavity pump (the inflation/deflation subunit) and a one-way valve (the switch subunit) located at the air inlet. EX1005, ¶[0109]; EX1003, ¶361. During operation, energizing the pump draws external air through the inlet into the cavity, increasing buoyancy and causing the robot to float. A POSITA would understand that activation of the pump opens the one-way valve to admit air while blocking backflow, allowing the cavity to fill and increase buoyant force. EX1005, ¶¶[0109]-[0111]; EX1003, ¶¶362-363.

b. Element [9b]

Wang teaches that the switch subunit is implemented by the **buoyancy-cavity pump** (5112) and the **one-way valve**. When the pump is idle, its sealed impeller housing closes the air path, isolating the air inlet–outlet subunit (air inlet 5113 and connection duct 5114) from the external atmosphere and preventing water ingress. EX1005, ¶[0111]; EX1003, ¶366. When the pump is energized, the seal is released, and ambient air is drawn through the inlet–outlet subunit into the buoyancy cavity (5111)—demonstrating that the switch subunit communicates with the outside atmosphere via the inlet–outlet pathway. *Id.*

10. Claim 10

Wang’s **processor** allows the robot to transition from a floating or surface-cleaning state (**third motion state**) back to a submerged state (**first motion state**) by reducing buoyant force. EX1005, ¶¶[0118]-[0120]; EX1003, ¶¶367-369.

Wang also teaches that the robot’s processor can receive target tasks from a user that include underwater cleaning. EX1005, ¶[0182]; EX1003, ¶370. Wang describes cleaning tasks that include both surface and underwater operations, which may be user-selected or automatically scheduled. EX1005, ¶¶[0182]-[0184]; EX1003, ¶¶371-372. A POSITA would understand that when the user input calls for underwater cleaning, the processor executes the sinking sequence—activating the buoyancy-control subsystem to discharge air and submerge the robot. *Id.*

11. Claim 11

Wang discloses this limitation. EX1003, ¶¶373-378.

Wang's robot includes a **buoyancy-cavity pump** (5112) (inflation/deflation subunit), a **one-way valve** (switch subunit), and a **buoyancy cavity** (5111) (airbag subunit), which are pneumatically connected to increase or decrease gas volume, thereby adjusting buoyancy based on cleaning tasks received from user input. EX1005, ¶¶[0182]-[0184]; EX1003, ¶¶373-376.

To achieve submersion, Wang explains that the processor activates the buoyancy-cavity pump and opens the one-way valve, allowing air to discharge from the buoyancy cavity. EX1005, ¶[0118]; EX1003, ¶377. Wang further describes controlling the motion state and buoyancy based on the completion of a surface cleaning task. EX1005, ¶[0120]; EX1003, ¶378.

12. Claim 13

Wang discloses claim 13. EX1003, ¶¶379-383. The '196 Patent describes a “**second predetermined condition**” as changing from a vertical to a horizontal position (e.g., from wall-climbing to floating). EX1001, 9:43-46.

Similarly, Wang's robot includes a **gyroscope** to detect **posture changes** and control the robot's transition from wall-climbing (second motion state) to floating (third motion state). EX1005, ¶¶[0068]-[0070], [0138]-[0139]; EX1003, ¶381. Wang additionally discloses that the cleaning device may have its attitude adjusted

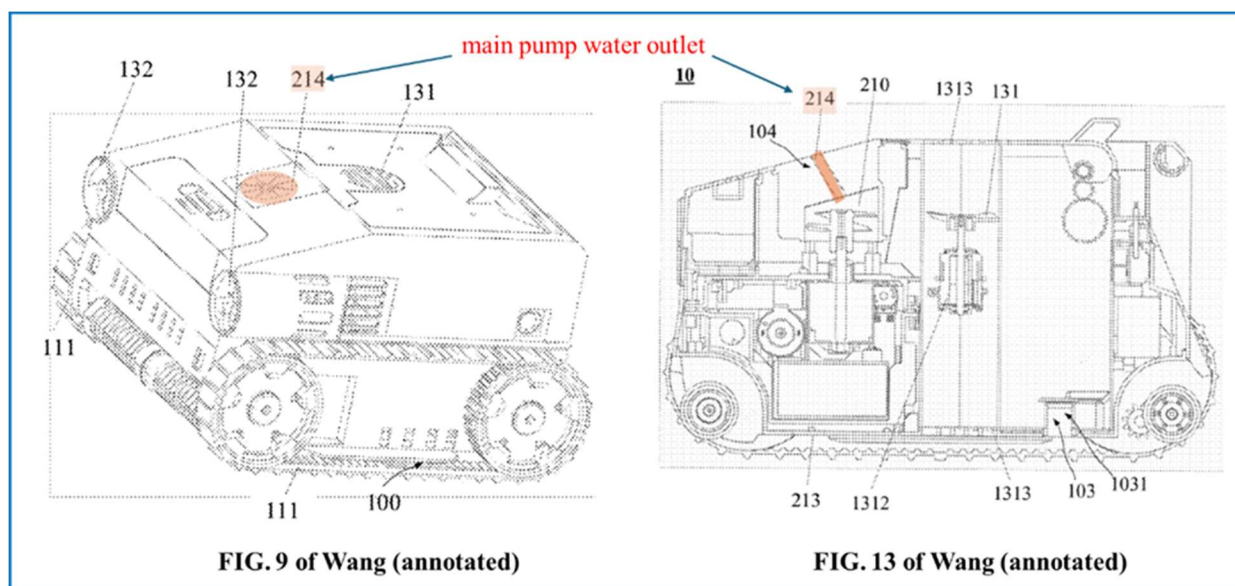
as it shifts between motion states, and that the motion state and attitude can be adjusted based on detection that an air inlet is exposed at a water surface. EX1005, ¶[0120]; EX1003, ¶382.

Thus, a POSITA would understand that Wang's control logic utilizes posture feedback to identify when the robot transitions from wall-climbing to floating (when the second predetermined condition is met), deactivating the pump and closing the valve after surfacing to stabilize buoyancy and prevent overinflation. EX1003, ¶383.

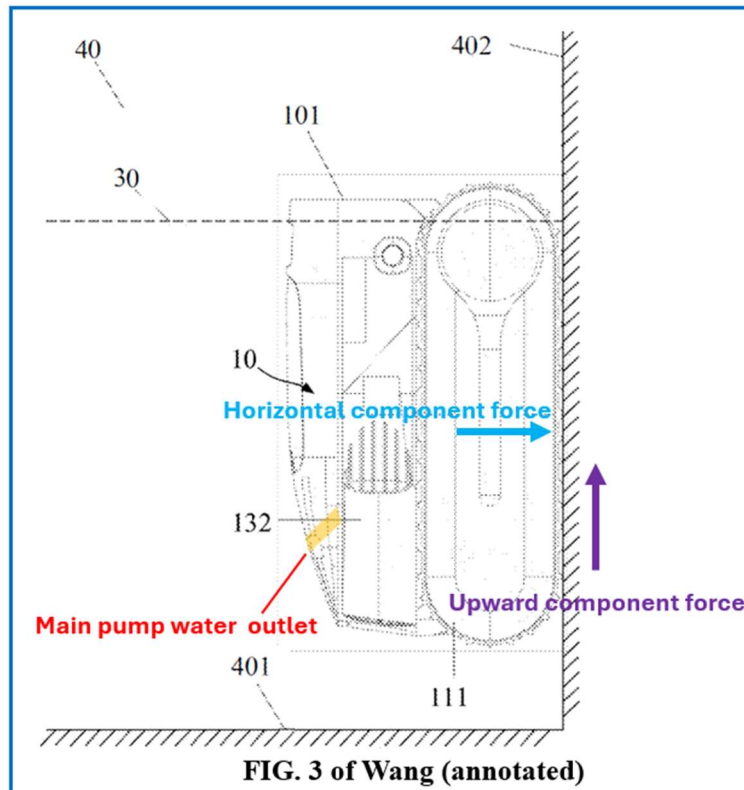
13. Claim 14

a. Element [14a]

Wang discloses that the **main water pump** (210) draws pool water through the liquid-inlet portion (103) and expels it via the liquid-outlet portion (104), thereby propelling and steering the robot and collecting debris. EX1005, ¶[0139], FIGS. 9, 13; EX1003, ¶¶384-385.



Wang further teaches that the orientation of the outlet (214) can be adjusted to apply directional thrust forces, such as improving tread contact with a wall during wall-climbing operation. EX1005, ¶[0143], FIG. 3; EX1003, ¶386.



b. Element [14b]

Wang discloses that the main water pump drives the robot to remain “tightly attached to the target side wall” during wall-climbing operation. EX1005, ¶¶[0144]-[0145]; EX1003, ¶387.

A POSITA would understand that when the robot transitions from wall-climbing (**second motion state**) to floating (**third motion state**), the suction force generated by the main pump must be **reduced**. EX1003, ¶388. A POSITA would view this adjustment as consistent with Wang’s overall control framework, in which the processor coordinates multiple subsystems—including buoyancy control and propulsion—to achieve stable transitions between the bottom, wall, and pool surface.

EX1003, ¶389. Accordingly, it would have been inherent and necessary for the water pump output to decrease once the robot begins to float, thereby releasing wall adhesion and float. *Id.*

14. Claim 15

a. Element [15pre]

This limitation is substantially the same as [1pre] above and is met for the same reasons. EX1003, ¶390.

b. Element [15a]

This limitation is substantially the same as [1d] above and is met for the same reasons. EX1003, ¶391.

c. Element [15b]

This limitation is substantially the same as [1e] above and is met for the same reasons. EX1003, ¶392.

d. Element [15c]

This limitation is substantially the same as [1f] above and is met for the same reasons. EX1003, ¶393.

e. Element [15d]

This limitation is substantially the same as [1g] above and is met for the same reasons. EX1003, ¶394.

15. Claim 16

This claim is substantially the same as claim 2 above and is met for the same reasons. EX1003, ¶395.

16. Claim 17

This claim is substantially the same as claim 3 above and is met for the same reasons. EX1003, ¶396.

17. Claim 18

This claim is substantially the same as claim 7 above and is met for the same reasons. EX1003, ¶397.

18. Claim 19

This claim is substantially the same as claim 13 above and is met for the same reasons. EX1003, ¶398.

B. Ground 2: Claims 8 and 12 are obvious under §103 over Wang in view of Zhao, Owen, and Guo

1. Motivation to Combine

Wang and Guo disclose complementary teachings addressing the same engineering challenge—controlling the buoyancy of a submerged pool-cleaning robot to ensure smooth transitions between underwater operation and surface floating. EX1003, ¶¶403–409.

Wang discloses multiple gas-supply sources for buoyancy adjustment, including both external and internal sources. EX1005, ¶[0107]; EX1003, ¶403. In addition to drawing air from the atmosphere once the robot surfaces, Wang teaches an internal gas-generation assembly that can produce or release gas to adjust buoyancy while submerged. *Id.* This design allows the robot to vary gas volume underwater, enabling ascent initiation before surfacing and improving overall operational efficiency. EX1003, ¶404.

Guo provides the complementary mechanical structure that enables this functionality. EX1003, ¶405. Guo discloses “a swimming pool cleaning robot capable of autonomous floating and diving underwater,” including a floating and diving assembly with an airbag connected to an inflation/deflation device via an air tube. EX1010, ¶¶[0004], [0008]. This assembly “drive[s] the swimming pool cleaning robot [] to ascend, descend, or suspend vertically.” EX1010, ¶[0031]. Guo further explains that the airbag is connected to a sealed cabin, serving as an internal gas source, with the inflation/deflation device transferring gas between the cabin and the airbag to control buoyancy. EX1010, ¶[0034], FIGS. 4–5; EX1003, ¶406. Because Guo’s system circulates gas internally within a sealed structure, it allows the robot to inflate its airbag while submerged, without relying on external air intake—directly supporting and reinforcing Wang’s disclosure of initiating buoyancy adjustment when the robot nears the waterline. EX1003, ¶407.

A POSITA would have been motivated to combine Wang and Guo to achieve a more effective and reliable buoyancy-control system. EX1003, ¶408. Wang provides the control logic, utilizing sensor feedback to detect proximity to the waterline and trigger buoyancy adjustment, while Guo provides the mechanical implementation, introducing an internal air-circulation system capable of inflating or deflating an airbag without exposure to atmospheric pressure. *Id.*

This combination would have been straightforward and predictable for a POSITA for several reasons: (1) Wang explicitly identifies the need to adjust gas volume while underwater and even contemplates an internal gas source for this purpose, which Guo directly provides through its sealed cabin; (2) integrating Guo's internal gas system into Wang's control framework would eliminate delay and instability caused by waiting for the air inlet to surface, allowing inflation to begin earlier based on sensor-detected proximity, which would yield smoother motion, reduced mechanical stress, and improved energy efficiency; and (3) both systems use standard pump–valve architectures and closed pneumatic circuits, making integration technically compatible and straightforward. EX1003, ¶409.

Accordingly, incorporating Guo's internal inflation/deflation system into Wang's sensor-driven buoyancy-control logic would have required only routine engineering adaptation without altering the underlying principles of operation. The result would have been predictable and advantageous—a buoyancy-control system

capable of initiating inflation immediately upon proximity detection, allowing the robot to approach and stabilize at the surface in a continuous, controlled manner. *Id.*

2. Claim 8

a. Element [8a]

This limitation is substantially the same as [7a] above and is met for the same reasons. EX1003, ¶399.

b. Element [8b]

Wang discloses this limitation. EX1003, ¶¶400-409.

When Wang’s processor receives the robot’s **vertical position (depth)** from a **first sensor** (proximity waterline-detection subunit) that meets a **preset condition** (“higher than a preset height”), the processor determines that the robot is near the surface and controls the buoyancy-adjustment assembly to increase gas volume in the buoyancy cavity, thereby initiating ascent toward the waterline. EX1005, ¶[0114]; EX1003, ¶¶401-402.

Wang teaches an **internal** gas-generation assembly located inside the robot, which can generate or release gas to adjust buoyancy even while the device remains submerged; thus, Wang’s system is capable of initiating buoyancy adjustment **while still underwater**. EX1005, ¶[0107]; EX1003, ¶¶401-404. Similarly, Guo’s design allows the robot to begin inflating its airbag before any portion of the robot emerges from the water. EX1010, ¶[0034]; EX1003, ¶¶405-409.

c. Element [8c]

This limitation is substantially the same as [7b] above and is met for the same reasons. EX1003, ¶410.

3. Claim 12

a. Element 12[a]

Wang discloses that the **buoyancy cavity pump 5112** can drive the buoyancy cavity 5111 to adjust the gas within the cavity. EX1005, ¶[0109], FIG. 6; EX1003, ¶411.

b. Element 12[b]

Wang, alone or in view of Guo, discloses this limitation. EX1003, ¶¶412-417.

Wang teaches a **one-way valve** that isolates the buoyancy cavity from external water whenever the air inlet is not exposed to air, thereby providing an automatic seal that functions as the switch subunit. EX1005, ¶[0109]; EX1003, ¶413.

Guo's inflation/deflation device 122 includes a peristaltic pump, gear pump, or Roots blower and an **electromagnetic valve** (i.e., the switch subunit). EX1010, ¶[0048]. Guo further explains that the electromagnetic valve controls the driving cabin and remains open when powered on and closed when powered off, thereby regulating airflow and maintaining seal integrity. EX1010, ¶[0049]; EX1003, ¶¶414-415.

A POSITA would have found it obvious to combine Wang’s **passive** inlet valve with Guo’s **electromagnetic valve** that opens only during pump operation. EX1003, ¶¶416-417.

C. Ground 3: Claims 1-6, 10, and 14-17 are obvious under §103 over Zhang in view of Zhao and Owen

1. Motivation to Combine Zhang and Zhao

A POSITA would have been motivated to combine Zhang and Zhao to enhance robotic pool-cleaner navigation and wall-cleaning performance. EX1003, ¶¶440–446.

Zhang teaches both the **control-level behavior**—including path planning and task-based actuation—and the **mechanical implementation** enabling the robot to locate and climb a wall based on operational requirements. EX1003, ¶440. Zhao, in turn, discloses a pool-cleaning robot equipped with a distance-measurement unit that enables the processor to locate the nearest side wall using the distance-measurement results. Specifically, Zhao teaches that “when the pool cleaning robot receives the **docking instruction**, the pool cleaning robot stops moving, determines the **closest pool wall** relative to the pool cleaning robot, and moves towards the closest pool wall.” EX1012, 4:62–5:2, 4:6-17, FIG. 1; EX1003, ¶441-442.

Both Zhang and Zhao concern **autonomous, underwater pool-cleaning robots** capable of operating along pool walls, sharing the same design objective:

improving efficiency and autonomy by enabling the robot to locate, approach, and climb walls for wall or waterline cleaning. EX1003, ¶443. Zhao provides the **distance-sensing** and **wall-finding** control logic, while Zhang provides the **multi-state motion control system** and **mechanical configuration** that allow the robot to crawl and clean along the wall once contact is established. EX1012, 4:62–65, 11:45–56, 13:23–33; EX1003, ¶444.

Dr. Cowan explains that Zhao’s distance-based detection logic and Zhang’s wall-climbing control mechanism are directly compatible and complementary: Zhao’s sensors deliver **real-time distance data** for wall approach and orientation, while Zhang’s drive and control system enables the robot to engage, climb, and clean once contact is made. EX1003, ¶445. Combining these features would yield a more complete and reliable control architecture—Zhao providing wall-detection feedback and Zhang providing wall-climbing actuation. *Id.*

Thus, a POSITA implementing Zhao’s control system would have found it obvious and advantageous to incorporate Zhang’s task-based motion control to enable full-cycle cleaning of the pool bottom, walls, and waterline. Conversely, a POSITA implementing Zhang’s robot would have found it obvious to add Zhao’s wall-finding logic to automate wall-climbing initiation. Both combinations produce predictable, beneficial results—enhanced autonomy, improved navigation accuracy,

and greater cleaning efficiency—consistent with the shared design objectives of both references. EX1003, ¶446.

2. Motivation to Combine Zhang and Owen

Dr. Cowan opines that by 2024, a POSITA was well acquainted with **timer- or timeout-based control** of pumps and motors, as these were standard functions in industrial and robotic control systems. EX1003, ¶¶459–460. Owen discloses precisely this type of control for inflatable systems, teaching timer circuits, integrated chips, or timer switches that operate a pump for a predetermined time and then automatically shut it off to prevent overinflation or motor damage. EX1013, 3:19–28, 4:7–10, 4:20–26; EX1003, ¶¶461–462.

Zhang teaches a **buoyancy-adjustment assembly**—including an airbag—that generates a buoyant force greater than its weight to maintain a cover underwater. EX1003, ¶463. In Dr. Cowan’s opinion, when the airbag embodiment is used, a POSITA would recognize the need for controlled inflation to prevent over-pressurization or excess battery consumption. EX1003, ¶464.

Integrating Owen’s **timer-based control** into Zhang’s **buoyancy system** would have been a straightforward and predictable design choice, allowing for precise, energy-efficient inflation control in a battery-powered submersible cleaner. The resulting buoyancy actuator would inflate only as needed to adjust position or

lift the cover, then automatically stop—avoiding overpressure, conserving power, and improving reliability. EX1003, ¶465.

Dr. Cowan further opines that Owen is analogous art to Zhang for the same reasons discussed regarding Owen and Wang. *See* Section VII-A-1d. The motivation to combine arises from well-established engineering objectives: (1) preventing rupture or structural stress on the airbag or connected components; (2) conserving battery power by avoiding continuous pumping; and (3) achieving consistent, repeatable actuation under varying water depths and environmental conditions. EX1003, ¶466.

Accordingly, a POSITA would have found it obvious to incorporate Owen’s timer shutoff circuit into Zhang’s buoyancy-control design. This modification would require only routine engineering adaptation, with a clear expectation of success and no teaching away in either reference. EX1003, ¶467.

3. Independent Claim 1

a. Element [1pre]

Zhang discloses a controllable sinking and floating swimming pool robot. EX1009, 1:51-57, 5:46-52, 4:1-9, 4:48-56; EX1003, ¶418.

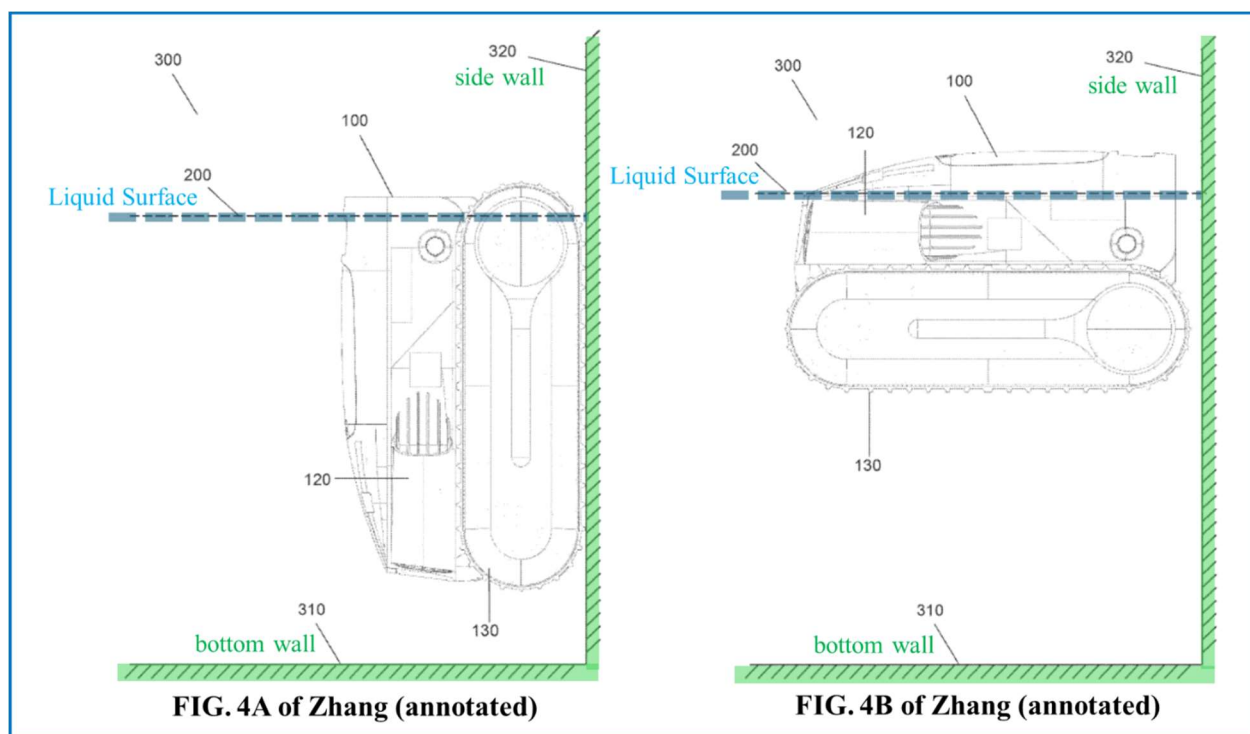
b. Element [1a]

Zhang discloses a **mode switching member** that controls the robotic cleaning device, allowing it to clean both on and beneath the pool water surface. EX1009, 4:24-30, 4:57-5:3, 8:21-31, 8:44-49, 13:58-61; EX1003, ¶¶419-422.

c. Element [1b]

Zhang discloses a waterline-detection unit configured to detect the robot's positional relationship to the waterline, where a **first sensor** continuously detects the robot's **vertical position (depth)** relative to the waterline, and a second sensor continuously detects whether the air inlet is above the waterline. EX1009, 7:34-44; EX1003, ¶423.

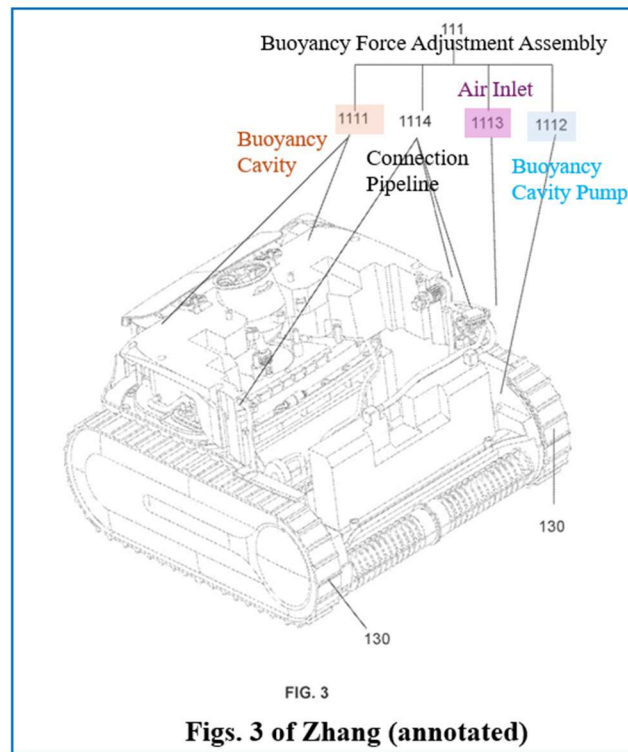
Zhang describes a processor obtaining position information in real time from the first sensor and adjusting buoyancy in response to a sensed preset condition that the position is higher than a preset height. EX1009, 7:51-8:11, FIGS. 4A, 4B; EX1003, ¶424.



Zhang also teaches that the cleaning device may use a **second sensor** to detect whether the air inlet of the device is exposed to air. EX1009, 8:12-16; EX1003, ¶425.

d. Element [1c]

Zhang discloses a **processor** that controls the **buoyancy force adjustment member** of the **mode-switching member** to adjust gas volume in the buoyancy cavity, thereby changing buoyancy and switching the robot's state between underwater cleaning and surface cleaning. EX1009, 7:45-51. Zhang's processor obtains data from sensors, determines when the cleaning device meets preset conditions, and controls the transition of the robot between submerged and floating states. EX1009, 7:45-8:11, 8:21-31, 8:37-40; EX1003, ¶¶426-428.

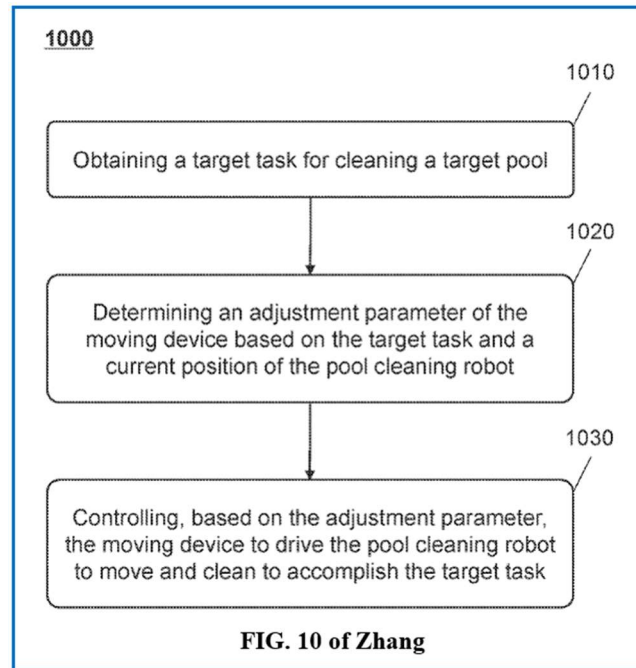


e. Element [1d]

Zhang, alone or in combination with Zhao, discloses this limitation. EX1003, ¶¶429-446. Zhang discloses that the pool cleaning robot operates based on operational requirement information, including user input or scheduled cleaning tasks. EX1009, 16:40-17:13, FIG. 10; EX1003, ¶¶430-433.

After obtaining the target task, Zhang teaches that the processor determines route and movement parameters needed to complete the task, including adjustment parameters for the movement mechanism. EX1009, 17:20-41, FIG. 10; Ex. 1003, ¶434. The adjustment parameters may include route information and a target-task position, both dependent on the robot's starting and current positions. *Id.* As Dr.

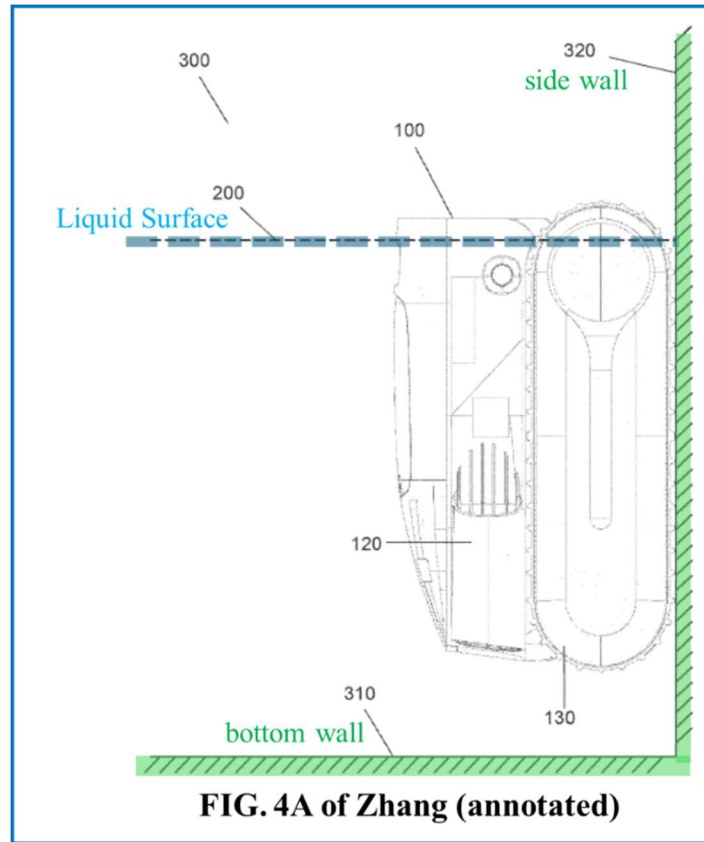
Cowan explains, these determinations constitute planning and directing the robot's movement based on task information. Ex. 1003, ¶435.



Even if not explicitly stated, Zhang's disclosed control logic inherently enables the processor to plan and direct movement based on the operational task—e.g., to travel from its current location to a side wall or slope when the task is to clean those surfaces. EX1003, ¶436.

Zhang further teaches that when the planned route brings the robot to the pool wall, the processor controls it to crawl upward along the wall or slope to perform cleaning. EX1009, 7:14-21, 11:45-49; 11:54-56, 17:42-55, FIGS. 4A, 10; EX1003, ¶¶437-439. Zhang also provides corresponding structural disclosure, including

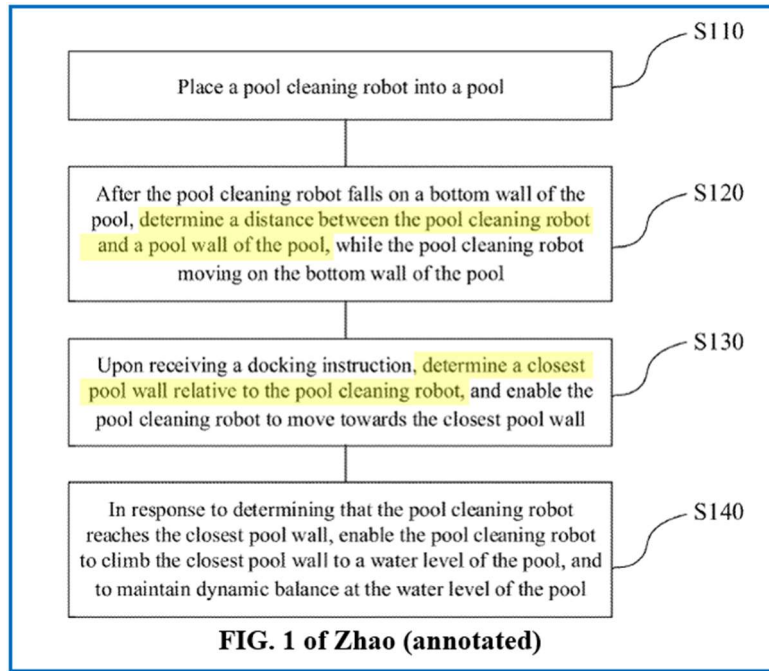
tracks for movement along the bottom wall and side wall. EX1009, 13:23-33;
EX1003, ¶439.



Zhang therefore teaches both the control-level behavior (path planning and task-based actuation) and the mechanical implementation enabling the robot to locate and climb a wall or slope based on user input. EX1003, ¶440.

Furthermore, Zhao discloses ultrasonic sensors used for distance measurement and “when the pool cleaning robot receives the **docking instruction**, the pool cleaning robot stops moving, **determines the closest pool wall** ..., and

moves towards the closest pool wall.” EX1012, 4:6-17, 4:62-5:2, FIG. 1; EX1003, ¶¶441-442.

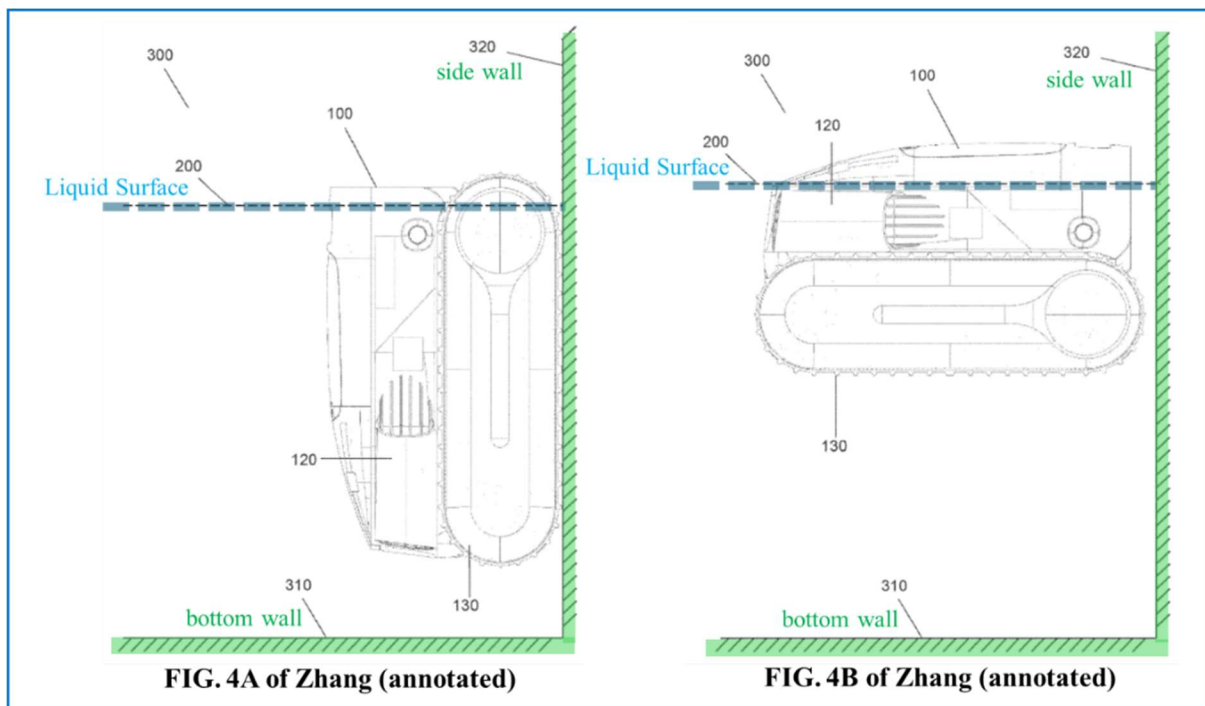


f. Element [1e]

Zhang discloses this limitation. EX1003, ¶447. Zhang describes how the processor obtains **position data** of the robot from a **first sensor** or a **second sensor** (i.e., the waterline detection unit) when transitioning between submerged and floating positions. EX1009, 7:34-44, 7:51-8:16, FIGS. 4A, 4B; EX1003, ¶447. The processor uses this **sensor data** to determine whether the cleaning device meets a **preset condition**—such as being above a **preset height** or whether the air inlet is **above water**—and based on that determination, controls the buoyancy adjustment part accordingly. *Id.*

g. Element [1f]

Zhang discloses this limitation. EX1003, ¶¶448-450. Zhang teaches that when the detected depth is shallower than a preset height or the air inlet is located in the air, processor starts pump 1112 to inject air into cavity 1111, thereby lifting inlet 1113 above the water surface and enabling the cleaning device to float. EX1009, 7:51-8:11, 8:21-31, FIGS. 4A, 4B; EX1003, ¶¶448-449.



Zhang further discloses the **pneumatic mechanism** by which buoyancy is actively increased to enter the floating working state. EX1003, ¶450. The buoyancy-adjustment system includes a buoyancy cavity pump (1112) connected to the air inlet (1113). During operation, the pump drives air into cavity (1111), increasing the

internal volume and buoyancy force so the robot floats. EX1009, 6:25-32, 6:64-7:11; EX1003, ¶450.

h. Element [1g]

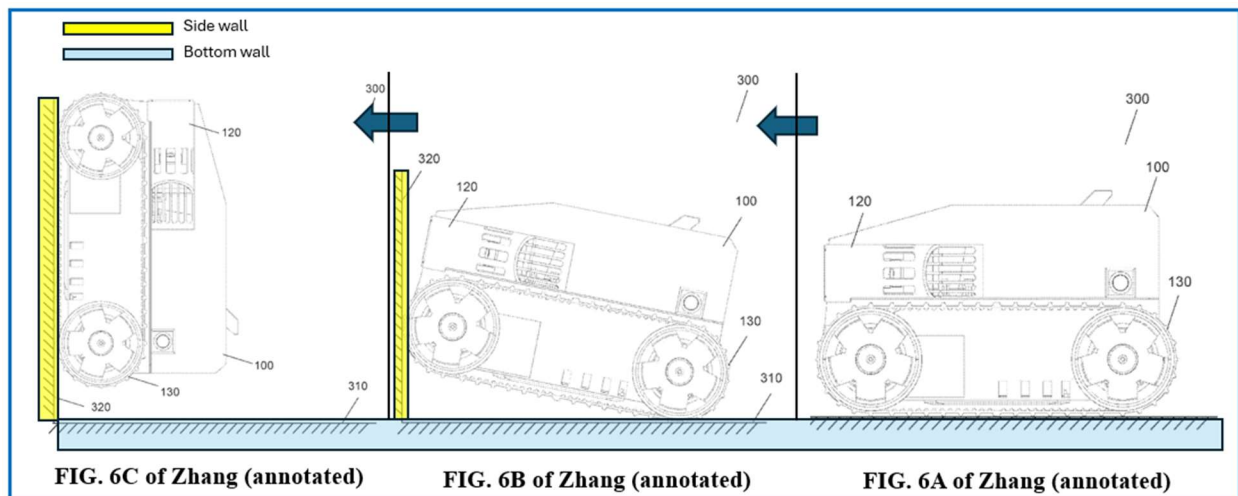
Zhang, in combination with Owen, discloses this limitation. EX1003, ¶¶450-467. Zhang teaches that when the robot is exposed to air, the processor controls the pump to **increase the gas volume** within the cavity, switching the device from the submerged to the floating state; additionally, the volume of the buoyancy cavity can be **preset**. EX1009, 5:4-21, 8:21-31; EX1003, ¶451. A POSITA would understand that this **preset volume threshold** inherently requires the pump to stop working after a **predetermined time** to prevent overinflation or damage to the buoyancy cavity. EX1003, ¶¶451-458. *See also* discussions in Section VII-A-2h.

Dr. Cowan further opines that by 2024, a POSITA was thoroughly familiar with using timers or timeouts to control pumps and motors, as these were standard functions in industrial and robotic control systems. EX1003, ¶¶459-460. Owen discloses exactly this type of solution for airbags and discloses timer circuits that run a pump for a **predetermined time** and then automatically shut it off—preventing overinflation or motor damage. EX1013, 3:19-28, 4:7-10, 4:20-26; EX1003, ¶¶461-462.

4. Claim 2

a. Element [2a]

Zhang, in combination with Zhao, discloses this limitation. EX1003, ¶¶468-474. Zhang teaches a pool-cleaning robot that transitions from underwater cleaning to surfacing by climbing the pool wall under a buoyancy-adjustment and propulsion system. EX1009, 7:14-21; EX1003, ¶468. When a surface-cleaning instruction is received, the robot determines its position at the pool bottom, plans a route, and climbs along the wall until part of the robot emerges from the water. EX1009, 16:42-53, 17:32-41, FIGS. 6A-6C; EX1003, ¶469.



A POSITA would recognize that Zhang's robot must detect a wall-climbing posture—a change from a state parallel to the pool bottom to one parallel to the wall—before initiating depth measurement or air-intake control. EX1003, ¶470. Without detecting this posture change, the system could not coordinate later actions

such as measuring distance to the waterline or activating buoyancy control. *Id.* Accordingly, Zhang inherently teaches a posture detection unit configured to detect the robot's posture. *Id.*

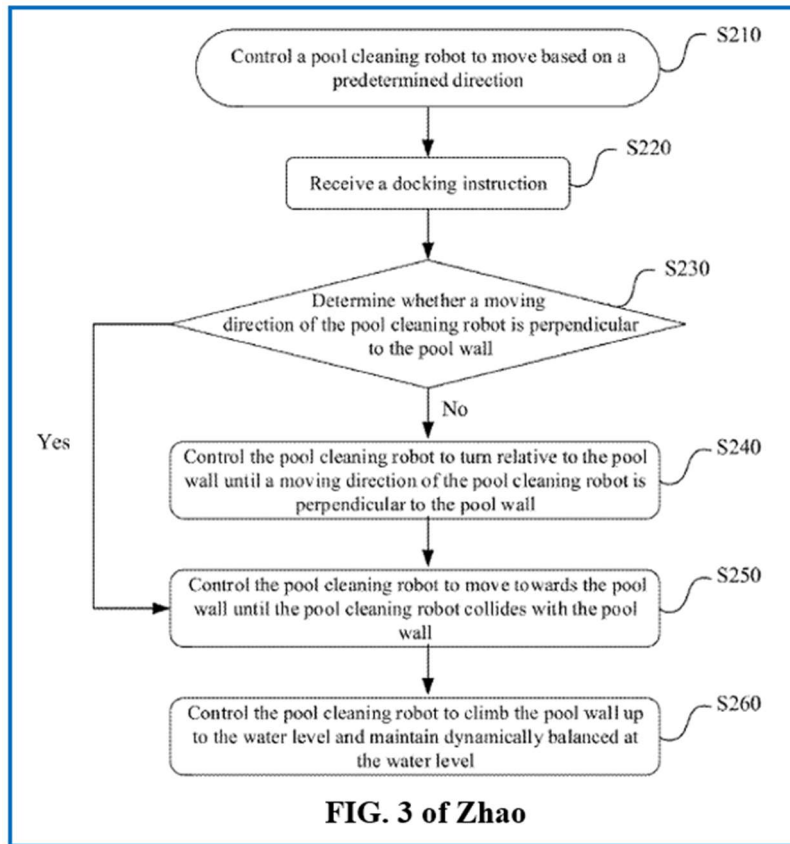
To the extent that Zhang does not disclose this feature, Zhao teaches it. EX1003, ¶471. Zhao discloses using a **gyroscope** to detect whether the robot is on the bottom wall or the side wall of the pool and to sense its inclination angle (posture) for wall-climbing control. EX1012, 4:23-25, 6:16-32, 7:1-7, 8:15-24; EX1003, ¶¶472-473.

b. Element [2b]

Zhang, in combination with Zhao, discloses this limitation. EX1003, ¶¶475-483. The '196 Patent describes the "first predetermined condition" as a **posture change**. EX1001, 9:37-40; EX1003, ¶476.

Zhang teaches that, upon receiving a water surface cleaning instruction, the processor determines its position, route and movement parameters, finds and climbs along the wall toward the water surface until part of the robot emerges from the water. EX1009, 17:14-31, 11:45-49; 11:54-56, 17:31-55, FIGS. 4A, 10; Ex. 1003, ¶477. A POSITA would recognize that for Zhang's robot to execute these sequential actions, it needs to sense that the robot's posture satisfies a specific condition (i.e., the transition from bottom cleaning to wall climbing) and in response initiate other sensing operations such as depth measurement and air-intake control. *Id.*

Zhao independently teaches a posture-based trigger of the same type. EX1003, ¶478. Zhao's robot determines whether it is on the bottom wall or side wall using gyroscope data to detect transition into wall-climbing mode. EX1012, 7:1-7; EX1003, ¶478. When the robot determines it has changed from the horizontal bottom to the vertical wall—i.e., when the posture meets the first predetermined condition—Zhao initiates its climbing and docking sequence, which necessarily includes detecting its positional relationship relative to the waterline. EX1012, 6:42-60, FIG. 3; EX1003, ¶¶479-480. During ascent, Zhao's gyroscope and counter record angle and height, tracking the robot's vertical position, and the system monitors distance to the water level. EX1012, 8:11-42; EX1003, ¶481. A POSITA would therefore understand that Zhao teaches this limitation. Ex. 1003, ¶482.



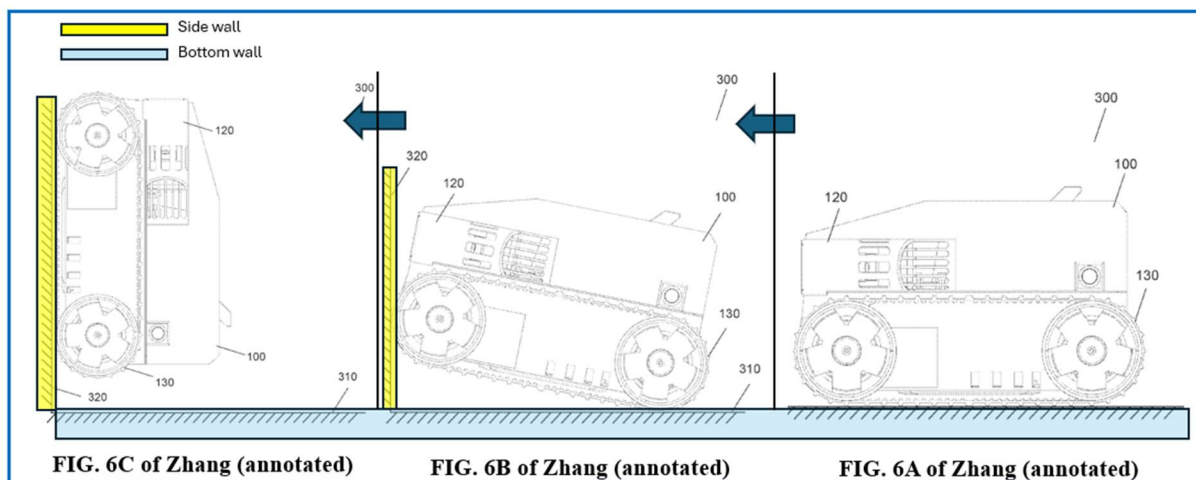
Zhang provides the mechanical framework for wall climbing, while Zhao supplies sensor-based control logic for determining when climbing begins and when positional detection relative to the waterline should start. Ex. 1003, ¶483. A POSITA would have found it obvious to integrate Zhao's gyroscope-based posture detection into Zhang's wall-climbing process to automatically trigger waterline detection once the robot tilts from horizontal to vertical. *Id.*

5. Claim 3

Zhang discloses a **task-acquisition module** that receives a cleaning task from a **user**, including tasks for cleaning water surfaces, underwater areas, the bottom, or walls. EX1009, 16:40-17:13; EX1003, ¶¶484-485.

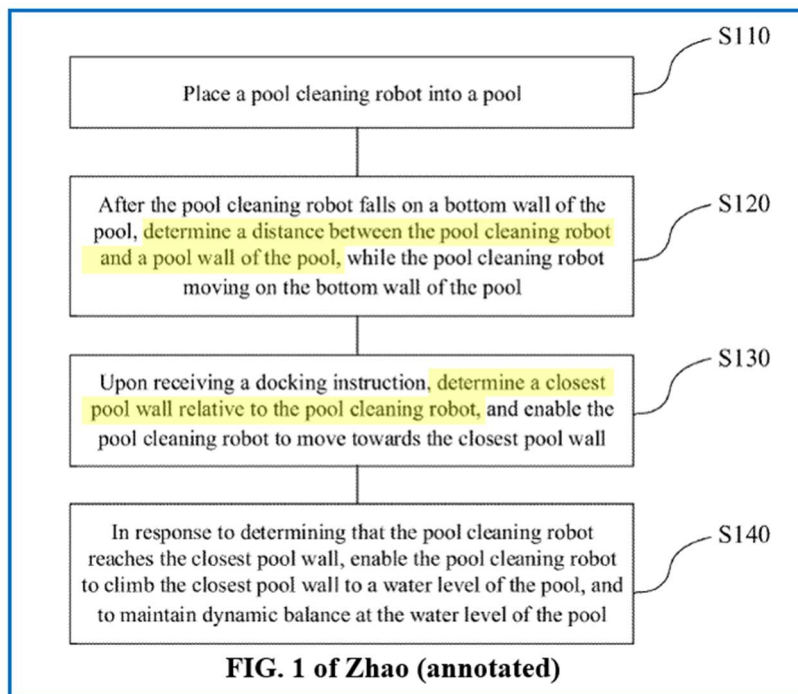
6. Claim 4

Zhang, alone or in combination with Zhao, discloses this claim. EX1003, ¶¶486-501. Zhang discloses a pool-cleaning robot with a position-sensing unit and a control member that plans a route from the sensed current position to a target task position and drives the robot along the path; for example, the robot may switch to a motion state in which it travels along the side wall while executing the planned route toward the target task location. EX1009, 15:31-43, 17:20-41, FIGS. 6A-6C, 10; EX1003, ¶487.



Accordingly, Zhang discloses control logic enabling the processor to (1) sense the robot's current position through onboard sensors, (2) plan a path to a target task location (e.g., a wall or slope), and (3) drive the robot along that route. EX1003, ¶488. A POSITA would understand that to execute this wall-cleaning task, the controller must determine which wall or slope is nearest and then navigate toward it using distance or positional information. *Id.*

To the extent Zhang does not explicitly reference a “nearest wall,” Zhao complements Zhang by providing the specific distance-sensing and mapping functions that identify and approach the closest wall. EX1012, FIG. 1; EX1003, ¶489.



Zhao teaches a sensor unit with ultrasonic distance sensors and gyroscopes that measure wall distances or use 3D-map information to locate the robot and

determine the closest pool wall. EX1012, 4:6-17; EX1003, ¶¶490-491. Zhao also describes gyroscopes and counters to calculate travel distance and orientation, and the use of map data to determine the robot's position within the pool. EX1012, 4:6-25, 7:1-7; EX1003, ¶¶492-493. It expressly teaches identifying the "closest pool wall" using distance data. EX1012, 1:38-42, 4:33-40, 4:62-65; EX1003, ¶¶494-496. Once the docking instruction is received, the robot executes navigation steps based on those measurements. EX1012, 6:33-37; EX1003, ¶497. Zhao further explains how the robot uses its sensors to orient itself relative to the closest wall for approach and docking. EX1012, 7:11-21; EX1003, ¶498.

Taken together, Zhang and Zhao disclose complementary elements of the claimed control architecture: Zhang provides the task-based route-planning, while Zhao provides the distance- and map-based sensing subsystem enabling determination of the nearest wall or slope. EX1003, ¶499.

7. Claim 5

Zhang discloses a second sensor that detects whether the air inlet is exposed to the air and at least a part of the robot has come out of the water. EX1009, 8:12-16; EX1003, ¶502.

8. Claim 6

Zhang discloses that the cleaning device includes a **first sensor** configured to determine the robot's **real-time position**, particularly its vertical position (depth) in

the pool. EX1009, 7:34-44; EX1003, ¶503. The first sensor, implemented as a pressure, ultrasonic, or optical sensor, detects the robot's current depth and transmits the positional data to the processor. *Id.*

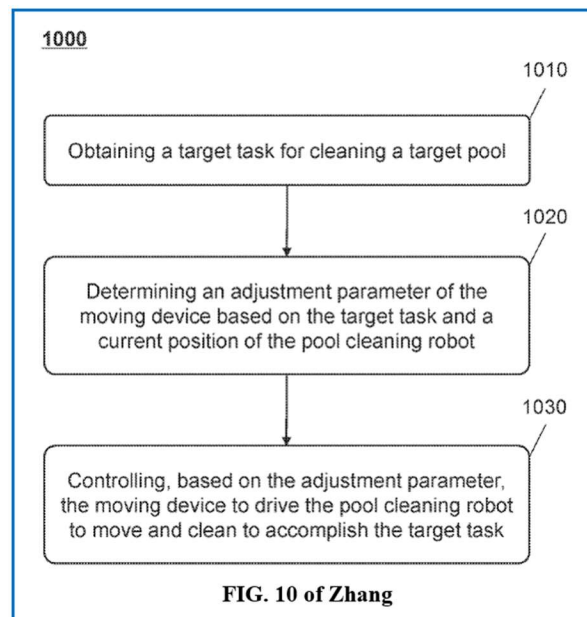
Zhang also teaches that when the robot transitions from an underwater to a surface position, the processor uses real-time position data from the first sensor to determines whether a preset condition is satisfied, such as the robot's depth being shallower than a preset height. EX1009, 7:51-8:11, FIGS. 4A, 4B; EX1003, ¶504. When that condition is met, the processor determines that the air inlet of the buoyancy cavity is above the water surface and activates the buoyancy pump to drain liquid and admit air. *Id.*

A POSITA would understand this control logic corresponds to the claimed proximity waterline detection function; specifically, the first sensor continuously monitors the robot's vertical position, and when it detects that the robot has ascended to within a predefined threshold distance of the waterline (i.e., a height greater than a preset depth), the processor recognizes that proximity condition and triggers the buoyancy-adjustment sequence. EX1003, ¶¶505-506.

9. Claim 10

Zhang's **processor** allows the robot to transition from a floating or surface-cleaning state back to a submerged, based on target task, by reducing buoyant force. EX1009, 8:37-49, 16:42-53; EX1013, ¶507. Zhang also teaches that the robot's

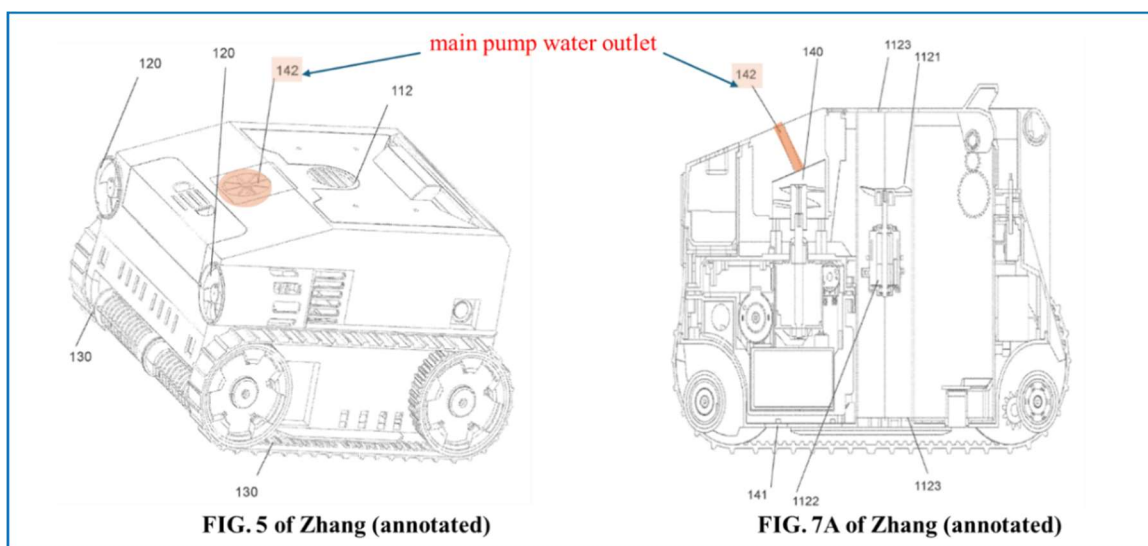
processor can receive “target tasks” from a user that include underwater cleaning. *Id.* When the user input calls for underwater cleaning, the processor executes the sinking sequence—activating the buoyancy-control subsystem to discharge air and submerge the robot. *Id.*; EX1009, FIG. 10.



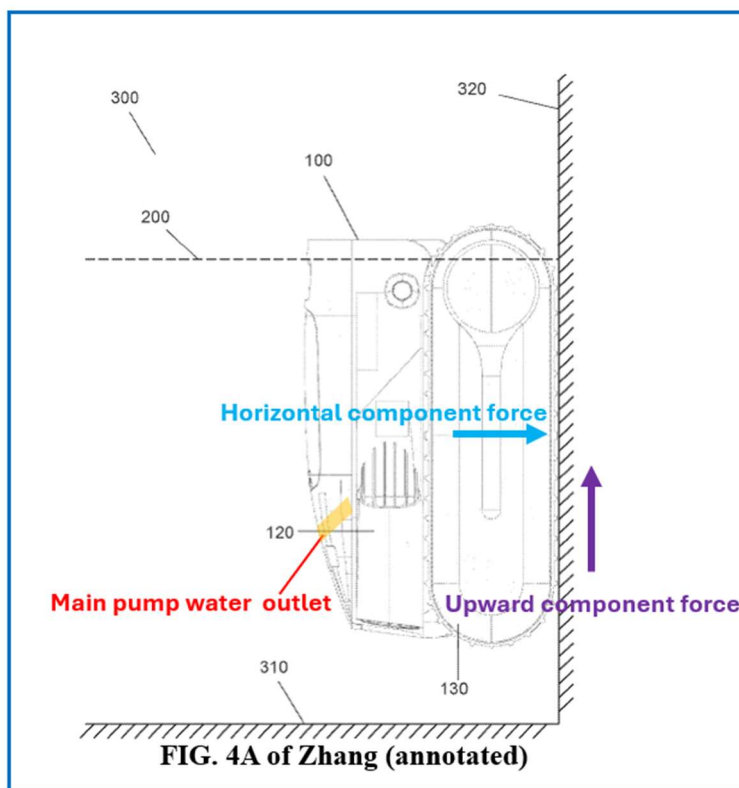
10. Claim 14

a. Element [14a]

Zhang discloses that the main water pump draws pool water through the liquid-inlet portion and expels it via the liquid-outlet portion, so the reaction thrust propels and steers the robot while simultaneously conveying debris into the cleaning device. EX1009, 12:13-29, FIGS. 5, 7A-7B, 8; EX1003, ¶508.



Zhang explains that the main pump water outlet is angled rearward relative to the housing to apply particular driving forces, such as improving tread contact with a wall along during wall-climbing operation. EX1009, 12:61-13:5; EX1003, ¶509.



b. Element [14b]

Zhang discloses the main water pump drives the robot to press against the side wall with a horizontal force component during wall-climbing operation. EX1009, 12:44-55; EX1003, ¶510. A POSITA would understand that, when the robot transitions from wall-climbing to floating, the suction force produced by the main water pump must be **reduced**. EX1003, ¶511.

A POSITA would view this adjustment as consistent with Zhang's overall control framework, in which the processor coordinates multiple subsystems—including buoyancy control and propulsion—to achieve stable transitions between the bottom, wall, and pool surface. EX1003, ¶512. Accordingly, it would have been inherent and necessary for the water pump output to decrease once the robot begins to float, thereby releasing wall adhesion and float. EX1003, ¶513.

11. Claim 15

a. Element [15pre]

This limitation is substantially the same as [1pre] above and is met for the same reasons. EX1003, ¶514.

b. Element [15a]

This limitation is substantially the same as [1d] above and is met for the same reasons. EX1003, ¶515.

c. Element [15b]

This limitation is substantially the same as [1e] above and is met for the same reasons. EX1003, ¶516.

d. Element [15c]

This limitation is substantially the same as [1f] above and is met for the same reasons. EX1003, ¶517.

e. Element [15d]

This limitation is substantially the same as [1g] above and is met for the same reasons. EX1003, ¶518.

12. Claim 16

This claim is substantially the same as claim 2 above and is met for the same reasons. EX1003, ¶519.

13. Claim 17

This claim is substantially the same as claim 3 above and is met for the same reasons. EX1003, ¶520.

D. Ground 4: Claims 1-8, 10-13, and 15-19 are obvious under §103 over Guo, in view of Zhao and Owen

1. Motivation to Combine Guo and Zhao

A POSITA would have had a clear motivation to combine Guo and Zhao. EX1003, ¶588. Both references operate in the same technical field—**autonomous**

pool-cleaning robots—and address the same engineering challenge: enabling the robot to autonomously reach and maintain a stable position at the waterline for cleaning, docking, or retrieval. *Id.* Guo provides the **buoyancy-control assembly**—an airbag connected to an inflation/deflation device via an air tube—while Zhao provides a **sensor-based positioning system** using ultrasonic sensors, a gyroscope, and a counter to detect proximity to the waterline. *Id.*

Because Zhao supplies the feedback mechanism required to detect and maintain waterline position, integrating Zhao’s sensing subsystem into Guo’s buoyancy-control framework would yield predictable results: a robot capable of stable flotation and waterline cleaning using well-understood buoyancy-control principles. *Id.*

The motivation to combine naturally arises from their shared design objectives, as both seek precise, automated transitions between underwater, wall, and surface operations. EX1003, ¶589. The integration would:

- (a) enhance surface stability through sensor-based feedback;
- (b) improve control accuracy via real-time waterline detection;
- (c) streamline transitions between submerged and surface states; and
- (d) utilize standard buoyancy hardware already present in Guo’s design.

EX1003, ¶¶589-590.

A POSITA would have been motivated to integrate Zhao’s communication and feedback framework into Guo’s buoyancy-controlled robot to achieve a fully **autonomous and user-interactive** cleaning system. EX1003, ¶653. Guo already provides the necessary mechanical and electronic infrastructure—a sealed driving cabin housing the controller and power supply—suitable for receiving, processing, and acting on external control and status data. *Id.* Integrating Zhao’s user-command interface and task-progress feedback would allow real-time coordination between the robot’s subsystems and user inputs, improving fault recovery, monitoring, and operational efficiency. *Id.* This combination aligns with well-established engineering trends toward intelligent, connected pool-cleaning robots and represents a predictable enhancement using known wireless-control and feedback technologies for their intended purposes. *Id.*

2. Motivation to Combine Guo and Owen

A POSITA would have recognized a clear motivation to combine Guo and Owen to achieve a safe, reliable, and automated **buoyancy-control system**. EX1003, ¶¶628–635. Guo provides the **mechanical buoyancy architecture**—an airbag and pump system for inflation and deflation—while Owen provides the **time-based control logic** that regulates inflation duration to prevent overinflation and component stress. EX1003, ¶¶629–630. Both employ standard pneumatic and

electronic control elements and share the same design objective: stable and efficient buoyancy management. *Id.*

Integrating Owen's **timer-controlled pump shutoff** into Guo's buoyancy assembly would enable the automatic termination of inflation after a predetermined interval, thereby maintaining safe pressure limits and preventing airbag damage. EX1003, ¶631.

Integrating Owen's timer control into Guo's buoyancy assembly would prevent overinflation and maintain safe pressure limits, while Zhao's timing and feedback logic would coordinate the floating and sinking sequence. EX1003, ¶¶631-632. The result would be a system capable of (1) detecting arrival at the waterline, (2) maintaining buoyancy for a preset surface-stay duration, and (3) automatically deflating to submerge—all using well-understood control techniques. EX1003, ¶¶633-635.

Dr. Cowan explains that Owen is analogous art to Guo, as both address control of air pumps and inflatable cavities. EX1003, ¶634. The motivation to combine arises naturally from their shared goals and compatible architectures—enhancing waterline stability, preventing overinflation, improving energy efficiency through time-limited inflation, and utilizing existing components within Guo's design. *Id.* Implementing this combination would require only routine programming of the controller to inflate the airbags upon reaching the waterline, run the pump for a fixed

time, maintain flotation for the preset period, and then deflate for descent—yielding a predictable and advantageous result: stable, time-bounded flotation without risk of overinflation. EX1003, ¶635.

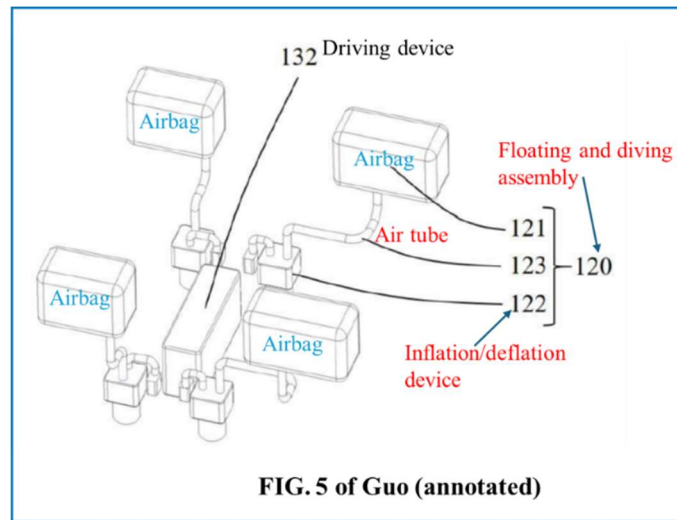
3. Independent Claim 1

a. Element [1pre]

Guo discloses a controllable swimming pool robot that includes a floating and diving assembly, which is “configured to drive the swimming pool cleaning robot [] to ascend, descend, or suspend vertically.” EX1010, Abstract, ¶¶[0004], [0008]; [0031]; EX1003, ¶576.

b. Element [1a]

Guo discloses a floating and diving assembly comprising an airbag and an inflation/deflation device configured to control the pool-cleaning robot’s floating and sinking operations. EX1010, ¶¶[0031], [0033]; EX1003, ¶577. Guo further explains that the inflation/deflation device draws gas from the driving cabin into the airbag to increase buoyancy and raise the robot to the surface, and returns gas from the airbag to the driving cabin to decrease buoyancy and submerge the robot—thereby providing active control over ascent and descent. EX1010, ¶[0034], FIG.5; EX1003, ¶¶577–578.



c. Element [1b]:

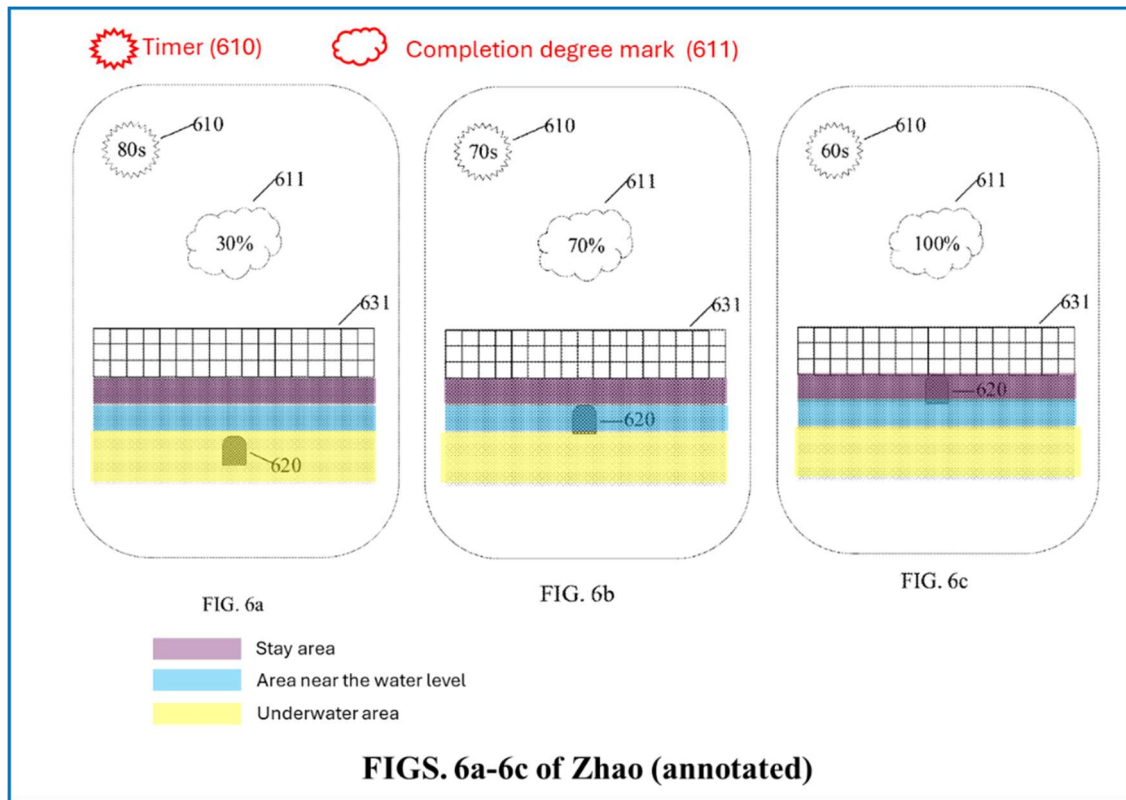
Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶579–590. Guo describes a pool-cleaning robot equipped with an **autonomous floating and diving assembly** that controls air exchange between an internal airbag and a sealed driving cabin to allow the robot to surface, dive, or float. EX1010, Abstract, ¶¶[0031], [0033]–[0034]; EX1003, ¶580. A POSITA would recognize that for Guo’s robot to operate stably and clean effectively at the surface, it must determine when it reaches or approaches the waterline to maintain precise buoyancy control. EX1003, ¶581. Accordingly, Guo inherently requires a mechanism to detect the robot’s position relative to the waterline. *Id.*

To the extent Guo does not expressly disclose this feature, Zhao teaches employing a waterline detection unit to determine the positional relationship between the robot and the waterline. EX1003, ¶582. Zhao’s robot sinks to clean

underwater surfaces and returns to the water surface for docking or retrieval, using ultrasonic distance sensors to measure distances to surrounding obstacles. EX1012, 3:9-11, 4:6-17, 6:16-21; EX1003, ¶582. Zhao explains that distance sensors can be mounted on the front, back, and sides of the robot. EX1012, 4:6-17.

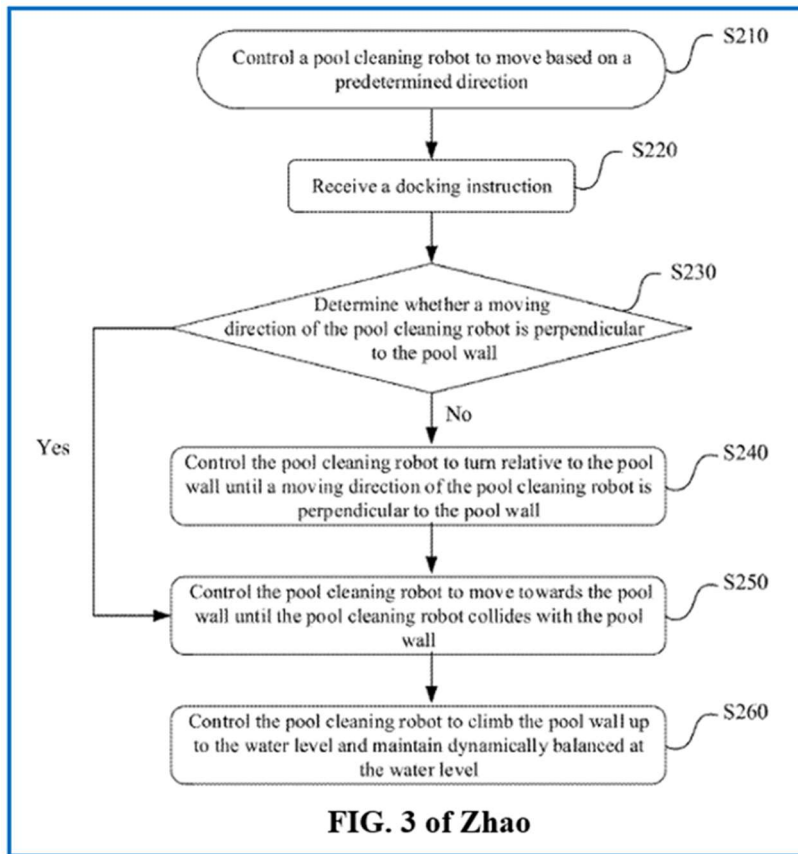
A POSITA would understand that when such ultrasonic sensors are positioned on the front or top of the robot, they inherently face upward as the robot climbs toward the surface, thereby measuring the distance to the air–water interface (i.e., the waterline) and functioning as a **waterline detection unit**. EX1003, ¶583. The '196 Patent itself confirms that ultrasonic sensors are suitable for waterline detection (EX1001, 8:29-47), reinforcing that this implementation was conventional and well understood. EX1003, ¶584. Accordingly, a POSITA would find it obvious that Zhao's ultrasonic sensors perform the same waterline-detection function during ascent. EX1003, ¶585.

Zhao further discloses the use of a **gyroscope** and a **counter** to determine position and distance data, including detecting when the robot reaches a predetermined distance from the waterline. EX1012, 6:25-32 (“**maintaining dynamic balance at the water level** can include sensing that the pool cleaning robot reaches the water level through sensors”), 7:1-7, 8:11-42 (describing a gyroscope and counter that record angle and height data to **track the robot's position relative to the waterline**); EX1003, ¶¶586-587.



d. Element [1c]

Guo, alone or in combination with Zhao, discloses this limitation. EX1003, ¶¶591-595. Guo teaches that the driving cabin contains a driving device including “a battery, **mainboard**, and drive motor, etc.” EX1010, ¶[0052]. A POSITA would recognize that Guo’s mainboard inherently serves as the controller responsible for coordinating the operation of the floating and diving assembly, as such control is essential for autonomous floating and diving. EX1003, ¶592.



Additionally, Zhao discloses a **controller** configured to manage the pool-cleaning robot's operations. EX1012, 3:41-42; EX1003, ¶593. Zhao explains that the controller can be a **CPU or microprocessor** electrically connected to a battery, memory, drive motor, movement unit, and sensor unit, executing programmed instructions to control movement and docking functions. EX1012, 3:41-47, claim 17, FIG. 3; EX1003, ¶¶593-594.

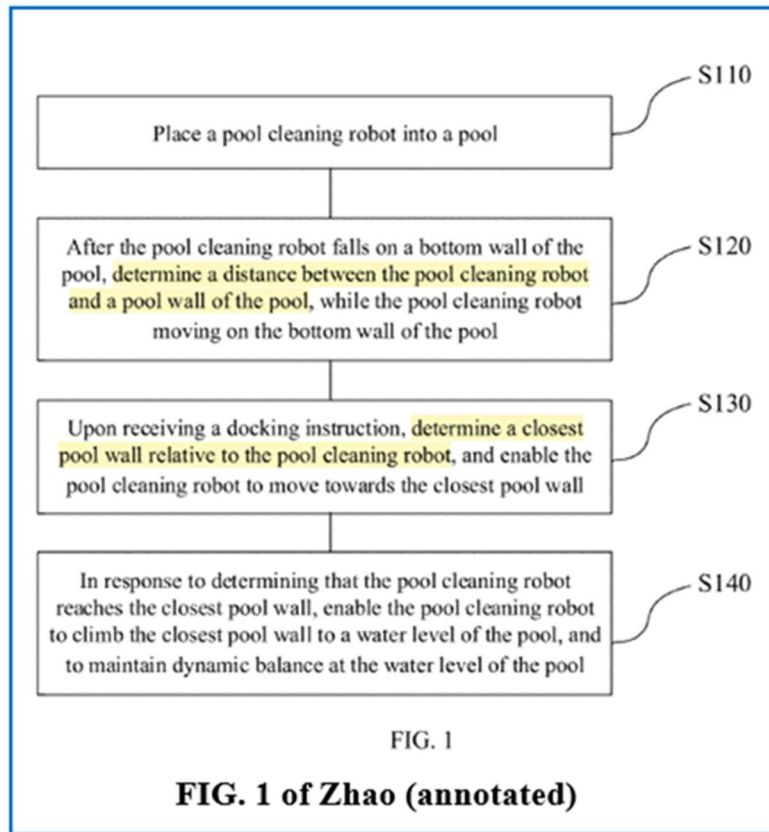
A POSITA would understand that Guo's mainboard and Zhao's controller perform the same control function—managing the operational states of the robot's buoyancy, propulsion, and sensing subsystems—and would find it obvious to

implement Guo's floating and diving control using Zhao's controller structure and logic. EX1003, ¶595.

e. Element [1d]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶596–601. Guo teaches that the robot is capable of cleaning the “bottom and walls of the pool.” EX1010, ¶[0055]. A POSITA would understand that Guo's mainboard inherently controls the robot's ability to locate and climb sidewalls to perform wall-cleaning operations. EX1003, ¶597.

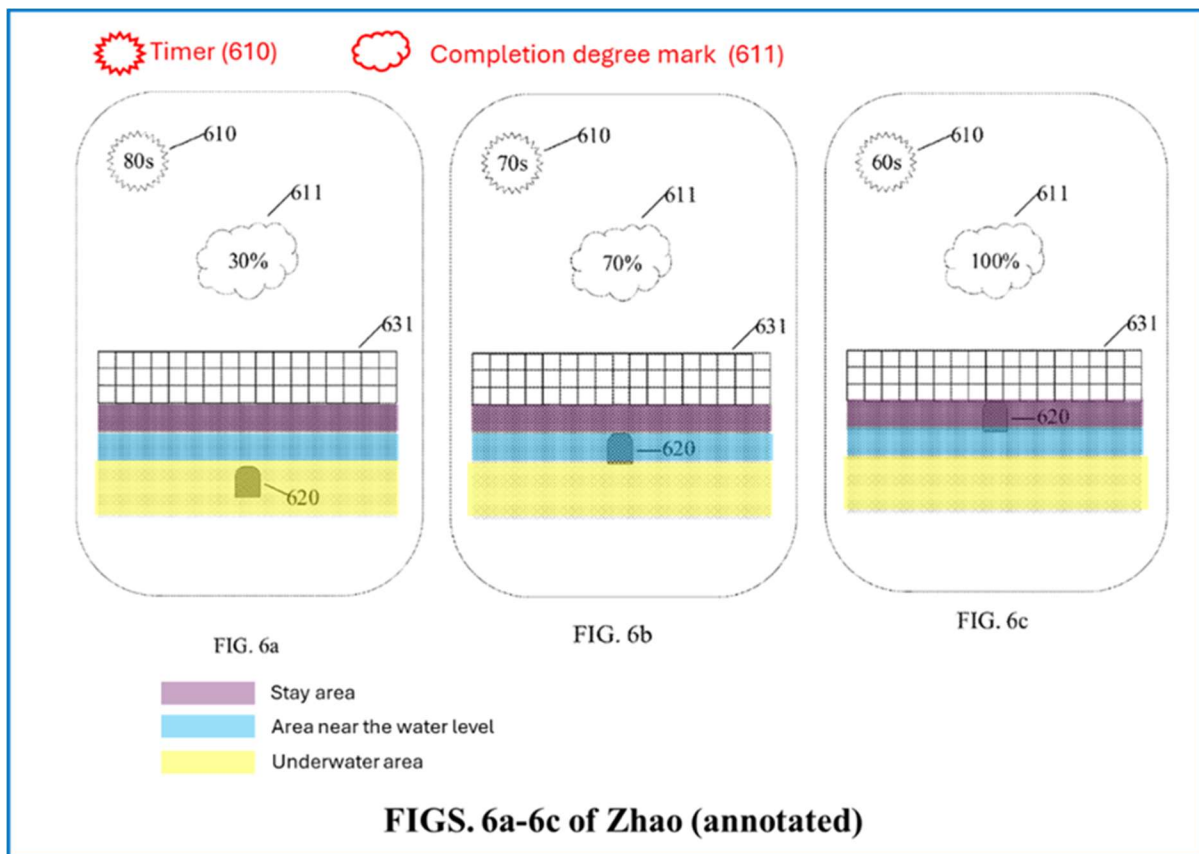
Zhao discloses this functionality. Zhao teaches that, upon receiving a docking instruction, the robot determines the closest pool wall and moves toward it. EX1012, 4:62-65, FIG. 1; EX1003, ¶598. Zhao further teaches the use of ultrasonic distance sensors, gyroscopes, and other sensors to measure distances to pool walls, identify the wall closest to the robot's position, and direct movement toward that wall. EX1012, 4:6-17, 4:62-5:2; EX1003, ¶¶599-600.



f. Element [1e]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶602–605. Guo teaches that the robot’s floating and diving assembly allows it to autonomously surface, dive, or suspend at any depth, including the water surface. EX1010, Abstract, ¶¶[0033]–[0034]. A POSITA would understand that such autonomous buoyancy control necessarily requires the controller to receive and process sensor feedback monitoring the robot’s position relative to the waterline, even though Guo does not explicitly depict these sensors. EX1003, ¶603.

Zhao provides explicit support for this control relationship, teaching that the controller obtains real-time position data from ultrasonic sensors, a gyroscope, and a counter as the robot transitions between submerged and surface positions. EX1012, 3:42-47, 4:6-8, 8:11-23 (“[a] **gyroscope** and a **counter** built-in the pool cleaning robot 620 can record an angle and a rising height of the pool cleaning robot ...”); EX1003, ¶604.



g. Element [1f]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶606–612. Guo teaches a **floating and diving assembly** comprising an airbag connected to an

inflation/deflation device that draws or discharges air to control the robot's ascent and descent. EX1010, ¶[0034]; EX1003, ¶¶607-608. Guo's inflation/deflation device includes **air pumps and valves** that activate to manage airflow for buoyancy control. EX1010, ¶[0042]. Thus, Guo provides the mechanical structure by which a controller can command the robot to float or dive. EX1003, ¶609.

Zhao supplies the complementary control logic governing these operations. EX1003, ¶610. Zhao describes that the robot automatically ascends to the water surface, detects when it reaches the waterline through sensors, **maintains dynamic balance** at the surface (i.e., in a floating working state) **for a predetermined time**, and then descends underwater. EX1012, 6:25-32, 8:59-9:4; EX1003, ¶610.

Dr. Cowan explains that Zhao's control system (1) detects via sensors when the robot reaches the waterline, (2) maintains a controlled floating state for a set period, and (3) terminates that state after a predetermined time, initiating descent. EX1003, ¶611. Zhao's control actions necessarily imply a subsystem that regulates buoyancy based on sensor feedback. *Id.*

h. Element [1g]

Guo, in combination with Zhao and Owen, renders this limitation obvious. EX1003, ¶¶613-635. Guo provides the **structural foundation** for sinking and floating control—a **floating and diving assembly** comprising an airbag and an inflation/deflation device (pumps and valves) connected through air tubing to

regulate buoyancy, enabling the robot to surface or dive. EX1010, ¶¶[0008], [0031], [0034]; EX1003, ¶614. A POSITA would recognize the risk of overinflation of Guo’s flexible airbag if the inflation/deflation device were continuously operated without limitation. EX1003, ¶615. Guo itself notes that the airbag material is “relatively soft” and requires protection against puncture. EX1010, ¶[0037]. Accordingly, a POSITA would have found it obvious to control the inflation/deflation device so that, once the robot entered a floating state, the system would automatically stop after a predetermined time to prevent overinflation and material stress. EX1003, ¶615.

Guo further emphasizes the importance of precise gas-volume control, explaining that each airbag is individually connected to its inflation/deflation device, allowing “more precise control of gas content” and thus the robot’s ascent or descent speed. EX1010, ¶[0039]; EX1003, ¶616. While Guo does not specify the control logic, Dr. Cowan opines that such control—setting a predetermined inflation time to reach the desired buoyancy—is routine, based on the fundamental relationship $V \approx Q \times t$. EX1021, Fig. 1; EX1003, ¶¶617-621. A POSITA would recognize that controlling the pump for a **fixed duration** to achieve a buoyancy threshold is a basic pneumatic control principle readily implemented using existing hardware. EX1003, ¶621.

Owen provides the explicit control scheme for achieving this result by teaching the use of timer circuit to energize a pump for a **predetermined time**, inflating an air bladder, and then automatically shutting it off to prevent overinflation. EX1013, 3:19-28, 4:7-10; EX1003, ¶624. Owen also teaches the interchangeability of timer switches and circuit boards, and the use of a pressure sensor for additional feedback control. EX1013, 4:20-26; EX1003, ¶624.

Zhao complements these disclosures by describing timing-based buoyancy control. EX1003, ¶625. Zhao teaches that the robot ascends to the surface, detects its floating position, **maintains balance at the waterline for a predetermined time**, and then submerges to resume cleaning. EX1012, 6:25-32, 8:35-42, 8:65-9:4, claim 2; EX1003, ¶¶625–626. Dr. Cowan explains that Zhao’s control steps necessarily rely on a buoyancy-control subsystem responsive to sensor feedback. EX1003, ¶627.

4. Claim 2

a. Element [2a]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶636–639. Guo teaches a pool-cleaning robot capable of floating, diving, climbing sidewalls, and “can be suspended at any position in the water.” EX1010, Abstract, ¶¶[0019], [0055]–[0056]; EX1003, ¶637. A POSITA would recognize that performing all those operations necessarily requires a posture detection unit, such as a gyroscope, to

monitor and maintain the robot's orientation—ensuring stability, preventing capsizing, and enabling smooth transitions between motion states. EX1003, ¶637.

Zhao discloses the use of a **gyroscope** to detect the robot's **posture** and determine whether it is positioned on the bottom or sidewall of the pool. EX1012, 4:23-25, 6:16-32 (“climb the pool wall can further include sensing a **change of an inclination angle** ... through the **gyroscope**”), 7:1-7, 8:15-24; EX1003, ¶638.

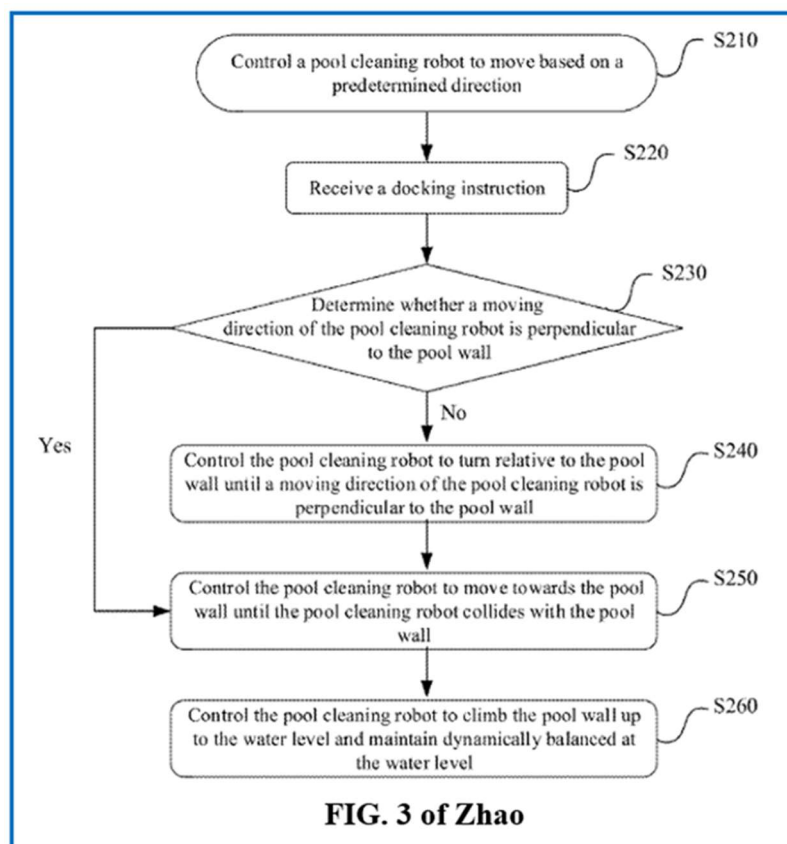
b. Element [2b]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶640–648. The '196 Patent describes the “first predetermined condition” as a **posture change**. EX1001, 9:37-40.

Guo teaches a robot capable of floating, diving, climbing sidewalls, and can be “suspended at any position in the water.” EX1010, Abstract, ¶¶[0019], [0055]-[0056]; EX1003, ¶642. Although Guo does not explicitly describe control logic linking posture detection to waterline detection, a POSITA would understand that waterline-related detections necessarily occur after a posture change is detected and the robot enters a wall-climbing state, providing feedback for the control unit to initiate buoyancy adjustment and transition to surface cleaning. EX1003, ¶642.

Zhao explicitly teaches posture-based control. EX1003, ¶643. Zhao's robot determines whether it is on the bottom or sidewall—that is, whether it has entered wall-climbing mode—based on **gyroscope data** from the posture-detection unit.

EX1012, 7:1-7; EX1003, ¶643. Dr. Cowan explains that once the robot detects a change from a horizontal bottom-cleaning posture to a vertical wall-climbing posture (i.e., the first predetermined condition), the robot initiates its docking and climbing sequence, which necessarily requires detecting its positional relationship relative to the waterline. EX1012, FIG. 3, 6:42-60; EX1003, ¶¶644-645.



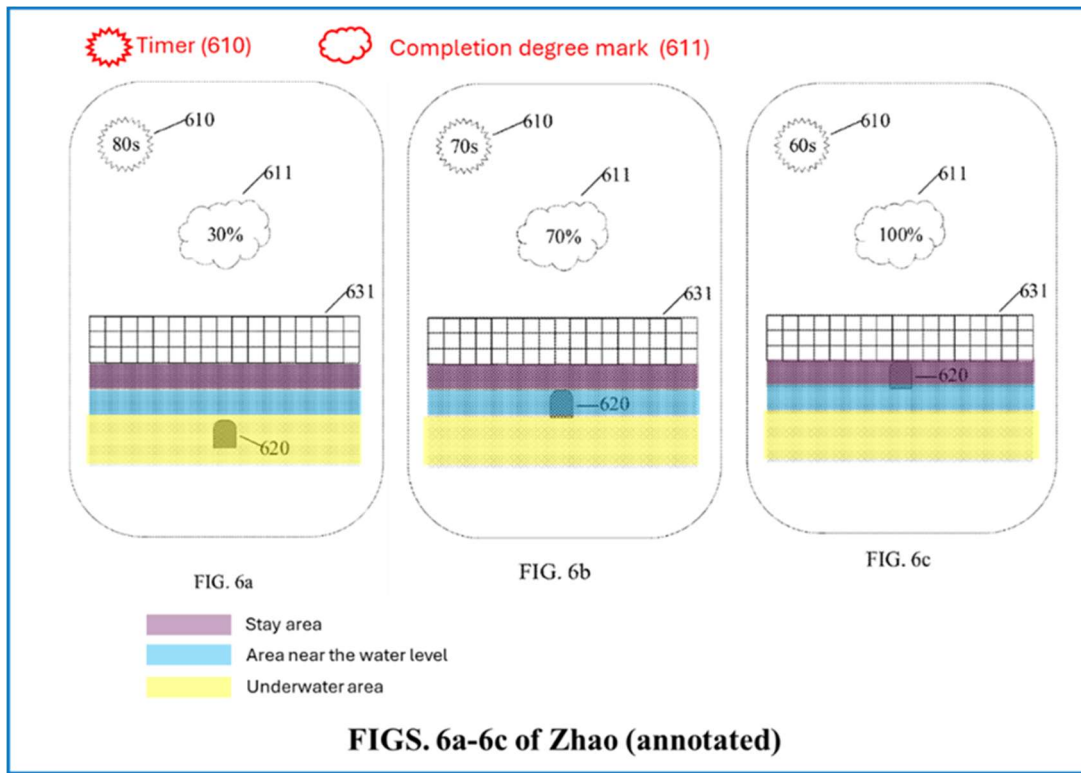
Zhao further teaches that during climbing, the gyroscope and counter record angle and height data, enabling the robot to **track its distance from the water level** and progression through underwater, near-water, and surface-level regions. EX1012, 8:11-23, 8:24-42; EX1003, ¶646. Dr. Cowan opines that Zhao thus teaches

controlling the waterline-detection unit to begin measuring positional relationship in response to the posture meeting the first predetermined condition, where posture triggers initiation of the waterline-detection and climbing sequence. EX1003, ¶647.

5. Claim 3

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶649-653. Guo teaches a structurally complete autonomous pool-cleaning robot capable of both **underwater** and **surface cleaning** through automated buoyancy control. EX1010, ¶¶[0019], [0031], [0052]. A POSITA would understand that such a system necessarily operates under **multiple control inputs** and environmental feedback signals—including task progress, timing, and power status—to coordinate its operational stages. EX1003, ¶650.

Zhao provides complementary teachings detailing the types of **operational information** used for control and feedback. EX1003, ¶651. Specifically, Zhao discloses that **user instructions**, such as docking commands, can be transmitted from a user terminal through a Wi-Fi communication module, allowing remote control of the robot. EX1012, 7:44-55, 8:6-10; EX1003, ¶651. Zhao also teaches that the robot generates and displays task-progress information during docking, including real-time completion status, remaining time, and percentage progress. EX1012, 8:24-42; EX1003, ¶652.



6. Claim 4

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶654-659. Guo provides the **structural foundation** for an autonomous pool-cleaning robot capable of floating, diving, and climbing sidewalls. EX1010, ¶¶[0019], [0031], [0034], [0055]-[0056]; EX1003, ¶655. Guo's buoyancy-control assembly, including its airbag and inflation/deflation device, enables full three-dimensional maneuverability. *Id.* A POSITA would recognize that, to perform effective wall-cleaning and spatial positioning in a confined pool, Guo's controller would necessarily rely on spatial feedback, such as distance or mapping data, to identify and approach nearby walls. EX1003, ¶656.

Zhao explicitly teaches such sensing and mapping functions. EX1003, ¶657. Zhao teaches that the robot includes ultrasonic distance sensors and gyroscopes; and based on the **distance-measurement results** or **3D map information**, the robot determines the closest pool wall relative to its position and moves toward that wall. EX1012, 1:38-42, 4:6-25, 4:33-40, 4:62-65, 7:1-7. Zhao further explains that the robot uses these sensors to navigate relative to the closest wall, determining both which wall is nearest and how to orient itself with respect to that wall. EX1012, 6:33-37, 7:11-21; EX1003, ¶658.

7. Claim 5

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶660-666. Guo teaches a pool-cleaning robot equipped with an autonomous floating and diving assembly that controls air exchange between an internal airbag and a sealed cabin, enabling surfacing and diving operations. EX1010, Abstract, ¶¶[0031], [0033], [0034]; EX1003, ¶661. Guo's robot can be "suspended at any position in the water," including the water surface, to perform cleaning tasks. EX1010, Abstract.

A POSITA would recognize that, for Guo's robot to maintain stability near the waterline and transition smoothly between submerged and surface states, the control system must receive feedback indicating when the robot begins to emerge from the water. EX1003, ¶662. Such feedback could be provided by an outlet-water detection

subunit that senses changes in buoyant force, pressure, or other sensor readings as the robot crosses the water–air interface. *Id.*

Zhao provides complementary teachings consistent with this functionality. EX1003, ¶663. Zhao’s robot includes “various types of sensors, such as collision sensors, distance sensors, counters, and gyroscopes” used to determine the robot’s position and operational state. EX1012, 4:6-8; EX1003, ¶663. Zhao further teaches that when the robot approaches the waterline, changes in buoyancy and gravity cause detectable variations in sensor readings, allowing the system to recognize that the robot has reached the surface. EX1012, 8:59-9:4; EX1003, ¶664.

Dr. Cowan explains that Zhao’s detection mechanism is based on the fundamental principle that buoyant and gravitational forces shift measurably only when an object begins crossing the air–water interface. EX1003, ¶665. When fully submerged, buoyant force equals the weight of displaced water and remains stable. As the robot begins to emerge, reduced displacement decreases buoyant force while gravity remains constant, producing detectable pressure, tilt, or acceleration changes sensed by Zhao’s onboard sensors. *Id.* Thus, a POSITA would understand that Zhao’s system inherently detects when part of the robot has emerged from the water—functionally equivalent to an outlet-water detection subunit. *Id.*

Dr. Cowan further opines that Zhao’s control logic inherently relies on a sensing function equivalent to such an outlet-water detection subunit—detecting

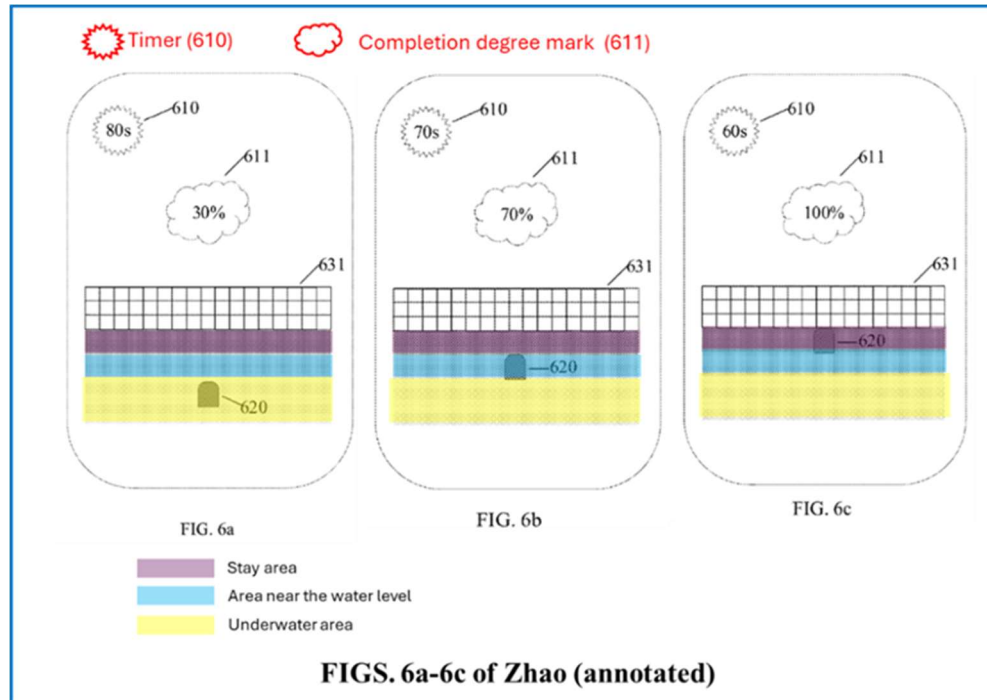
when at least a portion of the robot exits the water. EX1003, ¶666. Incorporating this functionality into Guo’s buoyancy-controlled system would provide real-time feedback to the main control unit, enabling stabilization of the robot’s air–water transition and balanced operation at the waterline. *Id.* The combination represents a predictable, complementary enhancement consistent with Guo’s design and well-understood in the art. *Id.*

8. Claim 6

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶667-671. Guo teaches a buoyancy-controlled pool robot capable of floating, diving, and climbing walls toward the water surface. EX1010, ¶¶[0034], [0055]-[0056]; EX1003, ¶668. A POSITA would recognize that to maintain stable ascent and smooth transition into surface-cleaning or docking states, the controller must determine when the robot is near—but not yet at—the waterline. EX1003, ¶668. Detecting proximity to the surface allows the system to adjust buoyancy and propulsion in time to prevent overshooting or instability at the waterline. *Id.*

Zhao discloses using a gyroscope and counter (i.e., a proximity waterline detection subunit) to detect positional and distance data for determining when the robot is within a predetermined distance from the waterline. EX1003, ¶669. During wall climbing, Zhao categorizes the robot’s position as being in an underwater area,

near-water-level area, or stay area at the water level, with a completion degree mark calculated from the robot's distance to the surface. EX1012, FIGS. 6a–6c.



Zhao further describes how the controller operates in relation to the water level, utilizing sensor feedback to manage transitions between submerged and surface conditions. EX1012, 8:11-42; EX1003, ¶670.

9. Claim 7

a. Element [7a]

Guo discloses this limitation. EX1003, ¶¶672-674. Guo's robot includes a first pump (i.e., inflation and deflation subunit) with a first valve (i.e., switch subunit) and a second pump (i.e., inflation and deflation subunit) with a second valve (i.e., switch subunit). EX1010, ¶¶[0042]-[0043]. During inflation, the first pump and

valve draw gas from the drive cabin into the airbag, and during deflation, the second pump and valve release gas from the airbag back to the drive cabin. EX1003, ¶672.

Guo also discloses that the inflation and deflation device includes a pump (i.e., inflation and deflation subunit) and a check valve (i.e., switch subunit), where the pump injects gas into the airbag and the one-way valve allows gas to leave the airbag while preventing reverse flow. EX1010, ¶¶[0045]-[0046]; EX1003, ¶673.

Guo further discloses a robot that includes an inflation and deflation device comprising a power mechanism (i.e., an inflation and deflation subunit) and an electromagnetic valve (i.e., a switch subunit). EX1010, ¶¶[0048]-[0050]; EX1003, ¶674.

b. Element [7b]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶675-681. Guo teaches a buoyancy-controlled swimming-pool cleaning robot that regulates ascent and descent using an inflation and deflation subunit (pumps) and a switch subunit (valves) to transfer air between a sealed driving cabin and an airbag. EX1010, ¶¶[0041]-[0050]; EX1003, ¶676. When surfacing, the system draws gas from the driving cabin into the airbag to increase buoyancy, and when diving, it reverses the process to submerge. EX1010, ¶¶[0034], [0041]-[0050]; EX1003, ¶676. A POSITA would understand that to achieve stable flotation at the waterline, the controller must

activate inflation and valve operations in response to feedback indicating that the robot has begun to emerge from the water. EX1003, ¶676.

Zhao provides the corresponding detection mechanism, teaching that the robot's sensors can detect when the robot reaches the water level and partially emerges from the surface. EX1012, 8:59-9:9; EX1003, ¶677. A POSITA would understand this detection of the buoyancy/gravity transition—physically corresponding to partial emergence from the water—as a clear indicator that the robot has begun to float. EX1003, ¶678. A POSITA would further recognize that this event provides the ideal trigger for activating Guo's inflation and valve-control system, initiating air intake and valve opening at the precise moment partial emergence is detected to stabilize the robot in its floating working state. *Id.*

10. Claim 8

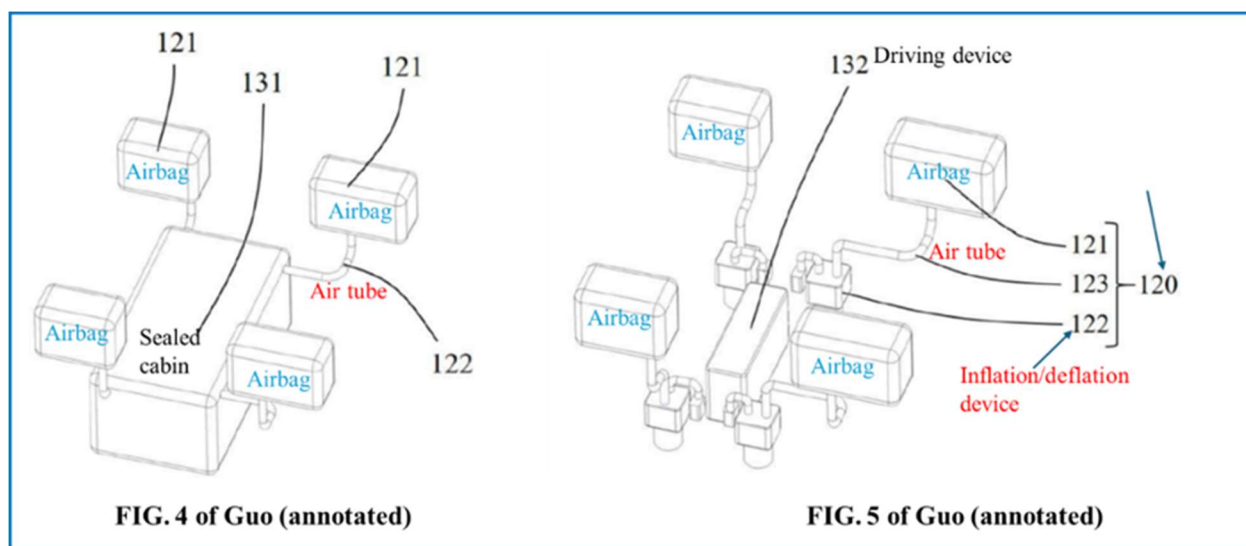
a. Element [8a]

This limitation is substantially the same as [7a] above and is met for the same reasons. EX1003, ¶682.

b. Element [8b]

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶683-690. Guo teaches a buoyancy-controlled pool-cleaning robot, including a floating and diving assembly in which the airbag is connected to a sealed driving cabin that serves

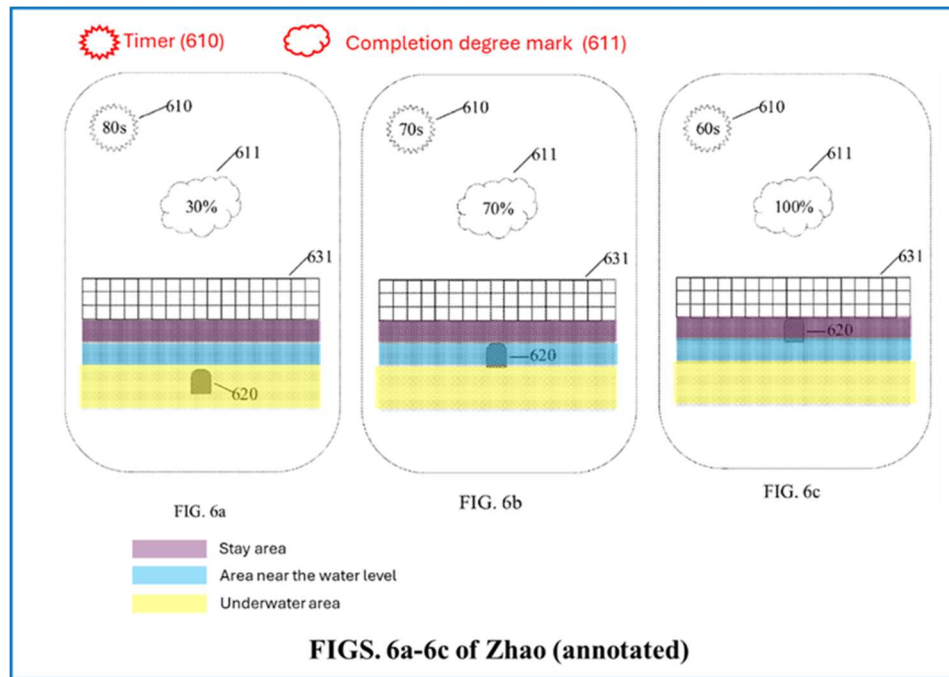
as an internal gas source. EX1010, Abstract, ¶¶[0034], [0055]-[0056], FIGS. 4-5; EX1003, ¶¶684-685.



Because Guo's system circulates gas internally within a sealed structure, it allows the robot to begin inflating its airbag before any part of the robot emerges from the water, relying solely on internal pressure transfer rather than external air intake. EX1003, ¶686. A POSITA would recognize this internal gas-exchange design as the precise mechanism enabling the robot to increase buoyancy when approaching the waterline without requiring exposure to atmospheric air. *Id.*

Zhao provides complementary sensing logic for initiating the inflation sequence. EX1003, ¶687. Zhao discloses the use of a gyroscope and counter (i.e., a waterline detection unit) to collect distance and positional data to determine whether the robot is within a predetermined distance from the waterline. *Id.* During wall climbing, Zhao indicates that the robot's status is displayed as being in an underwater

area, near-water-level area, or stay area at the water level, and that a completion degree mark is computed based on distance to the waterline. EX1012, 8:11-42, FIGS. 6a–6c; EX1003, ¶688.



Dr. Cowan opines that this sensor feedback is a natural control signal for adjusting buoyancy as the robot transitions from underwater to near-surface regions. EX1003, ¶689. He further explains that in this transition zone, mechanical traction diminishes because buoyant force offsets part of the robot's weight, reducing wall contact and propulsion efficiency. *Id.* To maintain a smooth ascent and stabilize at the waterline, the controller must compensate for reduced traction by increasing buoyancy, such as by activating the inflation mechanism to draw air into the airbag. *Id.*

c. Element [8c]

This limitation is substantially the same as [7b] above and is met for the same reasons. EX1003, ¶691.

11. Claim 10

Guo, in combination with Zhao, discloses this limitation. EX1003, ¶¶692–698. Zhao teaches that the main controller directs the pool-cleaning robot to submerge after a **predetermined period** at the water surface, in response to a timing or control condition. EX1012, 6:25-32; EX1003, ¶693. Zhao further explains that once the robot reaches the water level and begins timing, if the user does not retrieve it within the predetermined time, “the automatic docking procedure ends, and the pool cleaning robot retreats to continue cleaning work.” EX1012, 8:59-9:9; EX1003, ¶694.

A POSITA would understand this “predetermined time” or timing condition as a form of clock or scheduling information—one type of “operational requirement information” described in claim 3 of the ’196 Patent. EX1003, ¶695. Based on this timing input, the robot’s control logic directs the buoyancy-control system to end the floating phase and initiate sinking. *Id.*

While Zhao does not specify the hardware responsible for buoyancy reduction, Guo provides an explicit embodiment of a floating and diving assembly—an airbag connected to an inflation/deflation device (the sinking and floating control unit)—

that performs these functions. EX1010, ¶[0042]; EX1003, ¶¶696-697. Guo explains that to submerge, the air valve (switch subunit) and air pump (inflation/deflation subunit) are activated to discharge gas from the airbag into the sealed driving cabin, thereby reducing buoyancy and causing the robot to sink. EX1010, ¶[0042]; EX1003, ¶697.

A POSITA would recognize that Zhao's timing-based control signal provides the operational trigger, while Guo's airbag and pump/valve subsystem provides the structural means to execute that command. EX1003, ¶698. Integrating Zhao's timing logic with Guo's pneumatic buoyancy-control system would allow the controller to automatically activate the deflation mechanism—opening the valve and operating the pump—once the timing interval expires, thereby transitioning the robot into the sinking working state in a predictable, routine manner. *Id.*

12. Claim 11

Guo discloses this claim limitation. EX1003, ¶¶699-700. Guo discloses that entering the sinking working state requires opening a valve (switch subunit) and actuating a pump (inflation and deflation subunit) to discharge air from the airbag. EX1010, ¶[0042]; EX1003, ¶700. Specifically, Guo teaches a second pump and a second valve that operate together to expel air from the airbag into the drive cabin. *Id.*

13. Claim 12

Guo discloses this claim limitation. EX1003, ¶701. Guo discloses specific types of components that constitute the inflation/deflation device (inflation and deflation subunit), including a power mechanism, such as a peristaltic pump, a gear pump, or a Roots blower (i.e., an air pump assembly), and an electromagnetic valve (i.e., switch subunit). EX1010, ¶¶[0048]-[0049]; EX1003, ¶701.

14. Claim 13

Guo, in combination with Zhao and Owen, discloses this claim limitation. EX1003, ¶¶702-712. Guo discloses a buoyancy-controlled swimming-pool cleaning robot that uses an airbag and inflation/deflation device located within a sealed driving cabin to regulate ascent and descent by transferring air between the airbag and the cabin. EX1010, ¶¶[0031]-[0034], [0041]-[0042]; EX1003, ¶704. When surfacing, the pumps and valves are activated to move gas into the airbag, and when descending, they discharge gas back into the cabin. *Id.* Guo also notes that the airbag is made of flexible material and includes a protective cover to prevent damage from excessive pressure. EX1010, ¶[0037].

A POSITA would recognize that, once the robot has reached the floating working state (i.e., buoyancy exceeds gravity and the robot is floating on the water surface), continued inflation would be unnecessary and potentially harmful. EX1003,

¶705. It would therefore be obvious to stop the inflation/deflation device after a predetermined time or condition to prevent overinflation. *Id.*

Owen provides an established solution for such automatic control by teaching the use of timer circuit to allow a pump to run for a set period of time and then automatically shut off. EX1013, 3:19-28, 4:7-10, 4:20-26; EX1003, ¶706. These mechanisms ensure precise control of inflation duration and protect inflatable systems from damage caused by continuous operation. EX1003, ¶707. Accordingly, a POSITA would find Owen's control logic readily adaptable to Guo's airbag system to automatically close both the pump and valve after a defined interval or pressure condition. EX1003, ¶708.

Furthermore, Zhao provides complementary control logic identifying the condition that triggers this shutoff. *Id.* Zhao teaches that the pool cleaning robot determines its posture—specifically, whether it is located on the side wall or the bottom wall of the pool—based on gyroscope data. Ex 1012, 7:1-7; EX1003, ¶708. This posture feedback enables the controller to recognize the robot has entered floating working state by detecting that the robot transitions from a vertical climbing orientation to a horizontal cleaning orientation (i.e., second predetermined condition). EX1003, ¶709.

15. Claim 15

a. Element [15pre]

This limitation is substantially the same as [1pre] above and is met for the same reasons. EX1003, ¶713.

b. Element [15a]

This limitation is substantially the same as [1d] above and is met for the same reasons. EX1003, ¶714.

c. Element [15b]

This limitation is substantially the same as [1e] above and is met for the same reasons. EX1003, ¶715.

d. Element [15c]

This limitation is substantially the same as [1f] above and is met for the same reasons. EX1003, ¶716.

e. Element [15d]

This limitation is substantially the same as [1g] above and is met for the same reasons. EX1003, ¶717.

16. Claim 16

This claim is substantially the same as claim 2 above and is met for the same reasons. EX1003, ¶718.

17. Claim 17

This claim is substantially the same as claim 3 above and is met for the same reasons. EX1003, ¶719.

18. Claim 18

This claim is substantially the same as claim 7 above and is met for the same reasons. EX1003, ¶720.

19. Claim 19

This claim is substantially the same as claim 13 above and is met for the same reasons. EX1003, ¶721.

E. Ground 5: Claims 1-14 are unpatentable as being indefinite under 35 U.S.C. §112(b) (“main control unit”)

“Main control unit” is a means-plus-function limitation under 35 U.S.C. § 112(f). Claim 1 defines “main control unit” solely by its **function** without disclosing any structural detail. It uses a nonce term (“unit”) to perform the recited control operations: (1) find and crawl along a wall or slope; (2) determine the robot–waterline relationship; (3) enter a floating working state based on detection results; and (4) stopping that unit after operating in the floating state for a predetermined time. EX1003, ¶¶69–71.

Under *Williamson v. Citrix Online, LLC*, § 112(f) applies where the claim “fails to recite sufficiently definite structure” or recites a function “without reciting

sufficient structure for performing that function.” 792 F.3d 1339, 1349 (Fed. Cir. 2015) (en banc). As in *Williamson*’s “distributed learning control module,” the term “control unit”—and particularly “unit”—is a **generic, black-box label** that does not connote structure to a POSITA and simply stands in for “means.” *See id.* at 1350-51 (terms like “module,” “mechanism,” “element,” and other generic placeholders do not denote structure). The surrounding claim language likewise does not describe how the “main control unit” interacts with or is implemented in hardware/software to perform the recited functions. EX1003, ¶70. The presumption against § 112(f) is therefore overcome.

Once § 112(f) applies, claims are indefinite unless the specification discloses corresponding structure “clearly linked or associated” with each recited function. *Noah Sys., Inc. v. Intuit Inc.*, 675 F.3d 1302, 1311 (Fed. Cir. 2012). Here, the specification states only that “[t]he main control unit 10 is configured to control each component of the swimming pool robot ...,” which merely parrots capability and does not identify any structure or algorithm for performing the claimed control functions. EX1003, ¶73. The ’196 Patent thus fails to disclose any controller architecture, control logic, or algorithm linked to: path/wall-finding and crawling; waterline/position determination; commanding the sinking/floating unit into a floating state based on detections; and stopping that unit after a predetermined time. *See Williamson*, 792 F.3d at 1351–52 (absence of algorithm for computer-

implemented function renders claim indefinite). Accordingly, claims 1-14 are indefinite because the specification fails to disclose corresponding structure for “main control unit.”

If the Board declines to apply § 112(f), “main control unit” would at most refer to a **generic processor/controller** performing the recited functions. This Petition applies that construction for the prior-art grounds. Likewise, if the Board finds § 112(f) applies but perceives “corresponding structure,” the only plausible “structure” disclosed is a **generic processor** executing unspecified control, which this Petition also uses for the prior-art analysis in the alternative. EX1003, ¶75.

F. Ground 6: Claim 4 is unpatentable as being indefinite under 35 U.S.C. §112(b) (“distance measure unit”)

Claim 4 defines “distance measure unit” solely by its **function**—measuring distance—without disclosing any structural detail. The phrase “measurement unit,” and particularly the use of the generic word “unit,” would be understood by a POSITA as a nonce term that does not connote any definite structure and merely serves as a placeholder for an unspecified mechanism that performs the recited measurement function. EX1003, ¶108.

Because the claim language is expressed entirely in functional terms and recites no corresponding structure, the “distance measurement unit” limitation invokes means-plus-function treatment under 35 U.S.C. § 112(f). The omission of

the word “means” creates only a rebuttable presumption against § 112(f) applicability, and that presumption is overcome when—as here—the claim language merely states what the element does rather than what it is. *See Williamson*, 792 F.3d at 1349.

The express function recited for the “distance measurement unit” is to measure distance. The specification explains that “the distance measurement unit 50 performs distance measurement to control the swimming pool robot 1 to find the nearest side wall or slope,” and that the robot “rotates once in situ to detect distances L1–L4 ... so as to determine the nearest side wall Wr.” EX1001, 11:31-41, Fig. 7. Nothing in the claim language or specification identifies any structural component that performs this function—such as a particular type of sensor, circuitry, or software algorithm. EX1003, ¶¶110-111.

Once § 112(f) applies, the claim is indefinite unless the specification discloses corresponding structure clearly linked to the recited function. *Noah Sys., Inc. v. Intuit Inc.*, 675 F.3d 1302, 1311 (Fed. Cir. 2012). Here, the specification merely restates that “the distance measurement unit performs distance measurement,” without identifying any internal hardware configuration, algorithm, or programming logic for carrying out that function. EX1001, 9:58-66; 11:31-36. It does not describe whether the unit uses ultrasonic, optical, or pressure-based sensing, nor how any control calculations are implemented. EX1003, ¶¶110-113.

Even if the “distance measurement unit” were understood to encompass a generic processor or microcontroller executing control tasks, § 112(f) still requires disclosure of the algorithm that enables the processor to perform the claimed functions. *Aristocrat Techs. Austl. Pty Ltd. v. Int’l Game Tech.*, 521 F.3d 1328, 1333 (Fed. Cir. 2008). The ’196 Patent contains no such algorithmic disclosure. Accordingly, claim 4 is indefinite because the specification fails to disclose corresponding structure for the “distance measurement unit.”

If the Board declines to apply § 112(f), “distance measurement unit” should at most be construed to mean “a device that measures a distance between the robot and a surrounding object.” EX1003, ¶114. This Petition therefore applies that plain-meaning interpretation solely for purposes of the prior-art grounds.

VIII. CONCLUSION

Based on the foregoing, claims 1-19 of the ’196 Patent are unpatentable. Petitioner respectfully requests that the Board grant the Petition and cancel claims 1-19 for unpatentability.

IX. MANDATORY NOTICES

A. Real Party-in-Interest Under 37 C.F.R. § 42.8(b)(1)

Xingmai Innovation Technology (Suzhou) Co., Ltd. d/b/a Beatbot, Beatbot Technology (USA) Co., Ltd. and Deepwater Innovation Technology (Hong Kong) Limited are the real parties-in-interest.

**PETITION FOR *POST-GRANT* REVIEW
OF U.S. PATENT NO. 12,221,196**

B. Related Matters Under 37 C.F.R. § 42.8(b)(2)

Petitioner is not aware of any disclaimers, reexamination certificates, or petitions for *inter partes* or post-grant review for the '196 Patent, nor is Petitioner aware of any pending civil actions involving the '196 Patent.

C. Counsel and Service Information Under 37 C.F.R. § 42.8(b)(3) & (b)(4)

Petitioner provides the following designation of counsel. Petitioner consents to electronic service of documents to the email addresses identified below.

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PETITION FOR *POST-GRANT* REVIEW
OF U.S. PATENT NO. 12,221,196

D. Payment Of Fees Under 37 C.F.R. § 42.103

Petitioner authorizes the Patent and Trademark Office to charge Deposit Account No. 033975 for the petition fee and for any other required fees.

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

The undersigned certifies that the foregoing Petition complies with the type volume limitations of 37 C.F.R. §42.24(a)(1)(i). This Petition contains 17,401 words (excluding the table of contents, the table of authorities, mandatory notices under 37 CFR § 42.8, the certificate of service, certificate of compliance, and appendix of exhibits), as calculated by the “Word Count” feature of Microsoft Word 360, the word processing program used to create it.

The undersigned further certifies that this brief complies with the typeface requirements of 37 CFR § 42.6(a)(2)(ii) and typestyle requirements of 37 CFR § 42.6(a)(2)(iii). This Petition has been prepared in a proportionally spaced typeface using Microsoft Word in Times New Roman 14-point font.

Dated: November 10, 2025

Respectfully submitted,

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**PETITION FOR *POST-GRANT* REVIEW
OF U.S. PATENT NO. 12,221,196**

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true copy of the foregoing
PETITION FOR *POST-GRANT* REVIEW OF U.S. PATENT NO. 12,221,196
and supporting materials have been served in its entirety by electronic mail this
10th day of November, 2025, and to be sent by FedEx on November 11, 2025 on
the Agent for Patent Owner at the correspondence address for the attorney of
record for U.S. Patent No. 12,221,196 shown in USPTO Patent Center:

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