

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

PGR2026-00012

U.S. Patent No. 12,221,196

**PATENT OWNER'S PRELIMINARY RESPONSE**

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**INDEX OF EXHIBITS**

| Exhibit No. | Description                                                                                   |
|-------------|-----------------------------------------------------------------------------------------------|
| 2001        | Hugh Young and Roger Freedman, <i>University Physics with Modern Physics</i> (14th ed. 2016). |
| 2002        | <i>Oxford Dictionary of Computing</i> (6th ed. 2008).                                         |

## **I. INTRODUCTION**

Patent Owner Aiper Global Pte. Ltd. submits this preliminary response to the Petition for Post Grant Review (“Petition”) of US 12,221,196 (the “’196 patent”), filed by Xingmai Innovation Technology (Suzhou) Co., Ltd., D/B/A Beatbot (“Petitioner”).

There are seven grounds in the Petition:

| <b>Ground</b> | <b>Claims</b>     | <b>Basis</b> | <b>Prior Art/Reasoning</b>          |
|---------------|-------------------|--------------|-------------------------------------|
| 1             | 1-7, 9-11, 13-19  | 103          | Wang in view of Zhao and Owen       |
| 2             | 8, 12             | 103          | Wang in view of Zhao, Owen, and Guo |
| 3             | 1-6, 10, 14-17    | 103          | Zhang in view of Zhao and Owen      |
| 4             | 1-8, 10-13, 15-19 | 103          | Guo in view of Zhao and Owen        |
| 6             | 1-14              | 112(b)       | Indefinite                          |
| 7             | 4                 | 112(b)       | Indefinite                          |

The Board should deny institution because Petitioner has failed to demonstrate a reasonable likelihood of showing that any claim of the ’196 patent is unpatentable. In particular, all of the prior art grounds (i.e., grounds 1-4) rely on Owen, which is non-analogous art to the claimed invention – making all of those grounds improper for an obviousness challenge. And the Petition’s indefiniteness

arguments are contradicted by its claim construction and other arguments within the Petition.

## **II. OVERVIEW OF THE '196 PATENT**

The '196 patent is generally directed to an underwater robot for cleaning swimming pools and, more specifically, to “a controllable sinking and floating swimming pool robot and a sinking and floating control method for a swimming pool robot.” EX1001, 1:8-11. Swimming pool robots, at the time of invention of the '196 patent, were capable of “independently clean[ing] a bottom and wall surface of a swimming pool,” which provided an improvement over conventional manual cleaning methods. EX1001, 1:19-22. However, the current state of autonomous swimming pool robots still suffered from inefficiencies related to transitioning between cleaning states, specifically transitioning from a bottom floor cleaning state to a water surface cleaning state. EX1001, 1:23-27. These inefficiencies were the result of the buoyancy mechanisms these robots implemented, which involved the swimming pool robots absorbing water to cause itself to sink to the bottom of the pool followed by subsequent drainage to cause itself to float towards the surfaces of the pool. EX1001, 1:27-33. The inventors of the '196 patent sought to solve this very problem through an improved buoyancy mechanism that moved away from a water-intake/discharge method in favor of a gas-intake/discharge method. EX1001, 6:66-7:8.

As shown in FIG. 3, reproduced below, the '196 patent's pool robot includes a sinking and floating control unit 20:

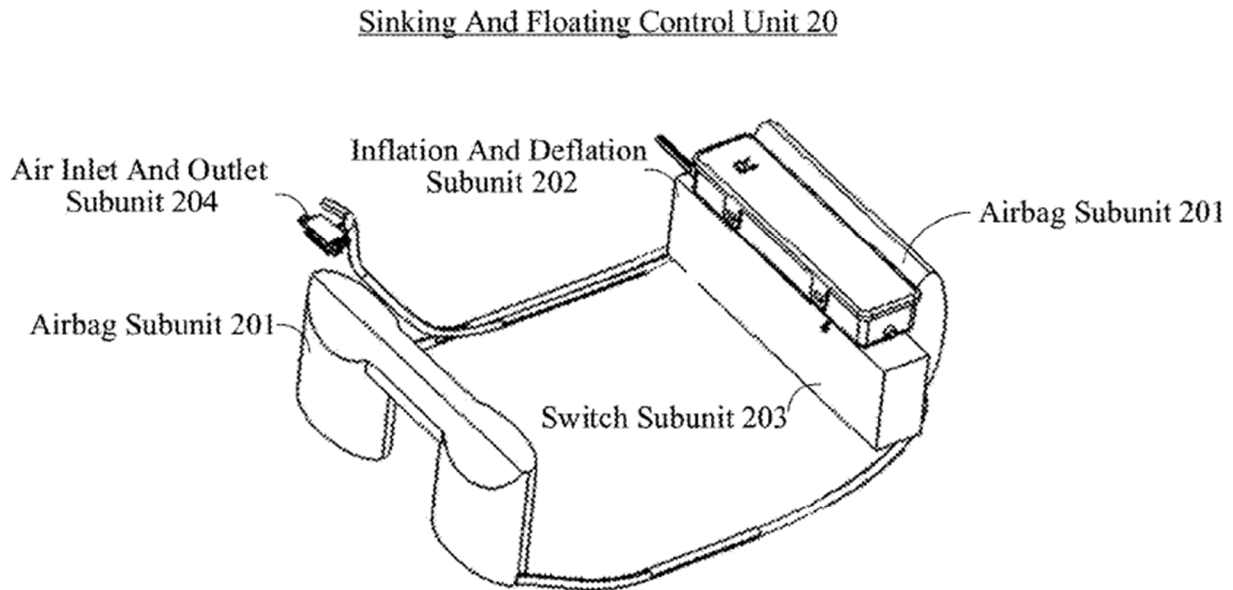


FIG. 3

EX1001, FIG. 3. The sinking and floating control unit 20 includes components that cause the pool robot to transition between a plurality of states by selectively inflating and deflating airbag subunit 201 using air. EX1001, 2:38-41 (“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”), 3:10-13 (“controlling the sinking and floating control unit to enter the sinking working state includes controlling the switch subunit to open and controlling the inflation and deflation subunit to discharge air in the airbag

subunit”). These plurality of states include a sinking working state, a floating working state, and a floating state.

**Sinking Working State:** In this state, the inflation and deflation subunit 202 is turned on to extract air from the airbag subunit 201, and the switch subunit 203 is turned on. EX1001, 6:52-54. Air in the airbag subunit 201 is discharged through the inflation and deflation subunit 202, the switch subunit 203, and the air inlet and outlet subunit 204, “so that the volume of the airbag subunit 201 becomes smaller and the buoyancy of the swimming pool robot 1 is reduced to sink.” EX1001, 6:52-59.

**Wall Climbing State:** In this state, the swimming pool robot has transitioned from cleaning the bottom of the pool to climbing along a side wall or slope toward the waterline. The robot’s posture changes “from a state parallel to the bottom surface of the swimming pool to a state parallel to the side wall of the swimming pool.” EX1001, 9:38-40. As the robot climbs, the waterline detection unit 30 monitors the robot’s position relative to the waterline using the proximity waterline detection subunit 302 (which detects whether the robot is within a predetermined distance, such as 10-20 cm, from the waterline) and the outlet water detection subunit 301 (which detects whether at least a part of the robot has emerged from the water). EX1001, 8:29-54.

**Floating Working State:** In this state, the inflation and deflation subunit 202 is turned on to suck air from outside, and the switch subunit 203 is turned on. EX1001, 6:10-13, 6:40-43. Air above the water level line enters the airbag subunit 201 through the air inlet and outlet subunit 204, the switch subunit 203, and the inflation and deflation subunit 202, “so that a volume of the airbag subunit 201 becomes larger and a buoyancy of the swimming pool robot 1 is increased to float.” EX1001, 6:40-48.

**Floating State:** In this state, the inflation and deflation subunit 202 and the switch subunit 203 are turned off. With both subunits closed, “the airbag subunit 201 is disconnected from the outside atmosphere, and the swimming pool robot 1 remains floating.” EX1001, 6:48-52.

**Transitioning between States:** The ’196 patent discloses a coordinated sequence of sensor-based triggers and control logic that govern transitions between states:

**Transition from Bottom Cleaning to Wall Climbing (First Predetermined Condition):** The robot includes a posture detection unit 40, which may be “configured by an inertial sensor,” that detects the posture of the swimming pool robot. EX1001, 9:31-32. The main control unit 10 controls the waterline detection unit 30 to start detecting the positional relationship between the robot and the waterline “when posture detection results of the posture detection unit 40 meet a

first predetermined condition (for example, changing from a state parallel to the bottom surface of the swimming pool to a state parallel to the side wall of the swimming pool).” EX1001, 9:31-38. This posture change indicates the robot has transitioned from floor cleaning to wall climbing.

**Transition from Wall Climbing to Floating Working State:** As the robot crawls along the side wall toward the water surface, the waterline detection unit 30 monitors the robot’s position relative to the waterline. EX1001, 8:29-37. The waterline detection unit 30 includes two subunits: proximity waterline detection subunit 302 and outlet water detection subunit 301. EX1001, 8:33-35. Proximity waterline detection subunit 302 is configured to detect whether the swimming pool robot has crawled to a distance less than or equal to a predetermined distance from the waterline (for example, 10 cm to 20 cm). EX1001, 9:40-44. This subunit “may be configured by an ultrasonic ranging device.” EX1001, 8:45-47. Outlet water detection subunit 301 is configured to detect whether at least a part of the swimming pool robot has come out of water. EX1001, 8:35-37. This subunit “is configured by a capacitive sensor” or “an ultrasonic ranging device.” EX1001, 8:38-40.

**Transition from Floating Working State to Floating State:** The ’196 patent discloses one or more conditions that may cause the sinking and floating control unit to stop working and enter the stable floating state:

**Sensor-Based Shutoff:** “[I]n response to the outlet water detection subunit 301 detecting that at least a part of the swimming pool robot 1 enters underwater again, the inflation and deflation subunit 202 and the switch subunit 203 are controlled to be closed.” EX1001, 9:5-8.

**Posture-Based Shutoff:** “[I]n response to the posture detection unit 40 detecting that the posture of the swimming pool robot 1 meets a second predetermined condition (for example, changing from a state parallel to the side wall of the swimming pool to a state parallel to the bottom surface of the swimming pool), the inflation and deflation subunit 202 and the switch subunit 203 are controlled to be closed.” EX1001, 9:41-47.

**Timer-Based Shutoff:** “[I]n response to...the outlet water detection subunit 301...not detect[ing] that at least a part of the swimming pool robot 1 enters underwater again after the sinking and floating control unit 20 enters the floating working state for a predetermined time (for example, 40 seconds), the inflation and deflation subunit 202 and the switch subunit 203 are controlled to be closed.” EX1001, 9:11-18.

### **III. SUMMARY OF REFERENCES IDENTIFIED BY PETITIONER**

Petitioner’s grounds rely on five references: U.S. Patent Application Publication No. 2025/0146315 (“Wang”) (EX1005), U.S. Patent No. 11,946,282 (“Zhang”) (EX1009), Chinese Patent No. 117738506 (“Guo”) (EX1010), U.S.

Patent No. 11,803,193 (“Zhao”) (EX1012), and International Publication No. WO 2007/106730 (“Owen”) (EX1013). A brief discussion of each reference is provided below.

**A. Wang, EX1005**

Wang is generally directed to a swimming pool cleaning device capable of switching between underwater and water surface cleaning modes. EX1005, Abstract. The cleaning device includes a mode switching member 510 that enables the device to transition between different operational states by adjusting forces applied in the vertical direction, including buoyancy adjustment. EX1005, ¶67.

As shown in FIG. 6, reproduced below, Wang’s cleaning device includes a buoyancy adjustment assembly 511:

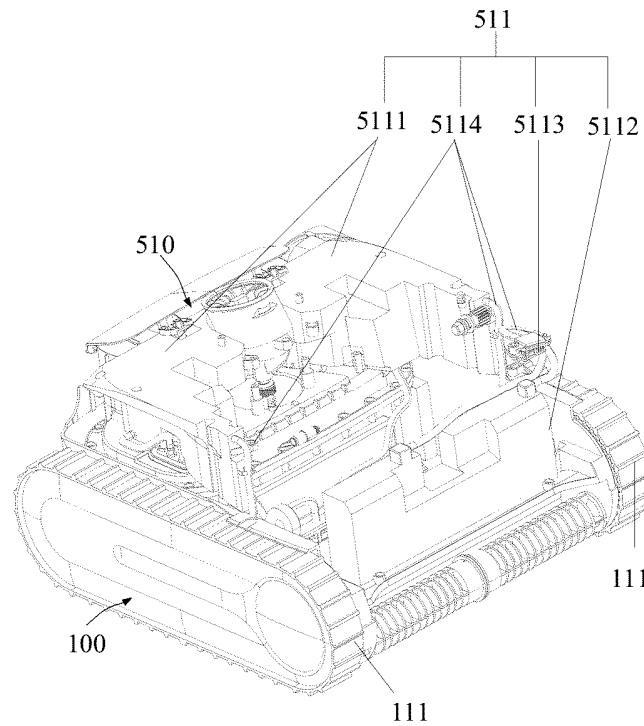


FIG. 6

EX1005, FIG. 6. The buoyancy adjustment assembly includes a buoyancy cavity 511, buoyancy cavity pump 5112, air inlet 5113, and connection duct 5114.

EX1006, ¶¶98-101. The buoyancy cavity 5111, together with the buoyancy cavity pump 5112, forms a buoyancy adjustment part that causes the cleaning device to transition between a plurality of motion states by selectively inflating and deflating the buoyancy cavity using gas. EX1005, ¶¶109-110. These motion states include a first motion state, a second motion state, and a third motion state.

**First Motion State (Bottom Cleaning):** Wang defines the first motion state as “a state in which the cleaning device 10 moves on the bottom wall 401, or an angle between the bottom wall 401 and an overall direction of the cleaning device

10 is less than 90° and the cleaning device 10 is away from the liquid surface 30.”

EX1005, ¶68. Wang further explains that “the cleaning device 10 is away from the liquid surface 30 may be understood as that the cleaning device 10 cleans the bottom of the pool or performs an action underwater.” EX1005, ¶68. In this state, the cleaning device performs underwater cleaning. EX1005, ¶69.

**Second Motion State (Wall Cleaning):** Wang defines the second motion state as “a state in which the cleaning device 10 moves on the side wall 402, or the overall direction of the cleaning device 10 is substantially parallel to the side wall 402.” EX1005, ¶68. In this state, “the cleaning device can clean a pool wall or a waterline.” EX1005, ¶70.

**Third Motion State (Surface/Floating):** Wang defines the third motion state as “a state in which the cleaning device 10 moves on the liquid surface 30, or the cleaning device 10 is at least partially exposed at the liquid surface 30, or the cleaning device 10 is entirely located under the liquid surface 30 and close to the liquid surface 30.” EX1005, ¶68. In this state, the cleaning device performs water surface cleaning. EX1005, ¶69.

Wang establishes a relationship between the motion states and gas volumes in the buoyancy cavity. Wang discloses that “[w]hen the buoyancy cavity 5111 adjusts the buoyancy force by using gas, the volume of the gas in the buoyancy cavity 5111 is set to be a gas volume threshold, so that a balanced force is applied

to the cleaning device 10 in the vertical direction. In this way, when the cleaning device 10 cleans the wall of the pool, the cleaning device 10 can be attached to the wall of the pool in the vertical direction and better clean the wall of the pool.” EX1005, ¶122.

Wang further explains that “[w]hen the cleaning device 10 is in the third motion state, there is a first volume of the gas in the buoyancy cavity 5111. When the cleaning device 10 is in the first motion state, there is a second volume of the gas in the buoyancy cavity 5111. The gas volume threshold is a value between the second gas volume and the first gas volume.” EX1005, ¶122.

Wang therefore establishes the following relationship:

| <b>Motion State</b> | <b>Location</b> | <b>Gas Volume</b>                   | <b>Buoyancy Effect</b>   |
|---------------------|-----------------|-------------------------------------|--------------------------|
| First motion state  | Bottom of pool  | Second volume (lowest)              | Negative (sinks)         |
| Second motion state | Pool wall       | Gas volume threshold (intermediate) | Neutral (clings to wall) |
| Third motion state  | Water surface   | First volume (highest)              | Positive (floats)        |

The express relationship is defined as: **Second volume < Gas volume threshold < First volume**. EX1005, ¶122.

The gas volume threshold creates “a balanced force...in the vertical direction” so that the cleaning device “can be attached to the wall of the pool in the

vertical direction and better clean the wall of the pool.” EX1005, ¶122. This neutral buoyancy allows the robot to cling to the wall during the second motion state without floating off or sinking.

**B. Zhang, EX1009**

Zhang is directed to a moving device for cleaning a swimming pool, including a buoyancy adjustment mechanism that enables the device to switch between underwater and water surface operation. EX1009, Abstract. The moving device includes a body with a buoyancy cavity that can accommodate liquid and/or gas, and a buoyancy force adjustment member (such as a pump) that adjusts the volume of gas in the buoyancy cavity to control the device’s buoyancy. EX1009, 4:61-6:24. Zhang discloses that “a volume of the buoyancy cavity 1111 may be preset” and that the buoyancy cavity “may be made of a flexible material and/or a rigid material.” EX1009, 5:8-10. Zhang’s control system is sensor-based: the processor obtains detection results of whether the air inlet is located in the air, and when the air inlet is exposed to air, the buoyancy force adjustment member is controlled to increase the gas volume to switch the device from below the liquid surface to above the liquid surface. EX1009, 7:34-44, 8:13-36.

**C. Guo, EX1010**

Guo is directed to a swimming pool cleaning robot with a floating and diving assembly that enables the robot to transition between underwater and

surface operation. EX1010, Abstract. Unlike Wang and Zhang, which draw air from the external atmosphere through an air inlet, Guo discloses a sealed internal gas circulation system in which “the driving cabin 131 [of the swimming pool cleaning robot 100] serves as the gas source for the airbag 122 [of floating and diving assembly 120].” EX1010, ¶56. When the robot needs to surface, the inflation/deflation device draws gas from the sealed driving cabin into the airbag; when the robot needs to dive, the inflation/deflation device discharges gas from the airbag back into the driving cabin. EX1010, ¶19, ¶34, ¶48, ¶52, ¶56. This closed-loop system means the total gas volume is finite and simply transfers between compartments within the robot.

**D. Zhao, EX1012**

Zhao is directed to an automatic docking method for pool cleaning robots that enables the robot to autonomously navigate to the nearest pool wall, climb to the water surface, and maintain dynamic balance at the waterline for user retrieval. EX1012, Abstract. The alleged invention addresses the problem of user inconvenience: traditional pool robots are heavy and require manual pulling or use of cables/hooks to retrieve, which can damage the robot. EX1012, 1:24-35. Zhao’s robot uses ultrasonic sensors positioned on the front, rear, left, and right sides to measure distances to pool walls, and a gyroscope to detect posture changes. EX1012, 4:6-17, 5:3-14. Upon receiving a docking instruction, the robot

determines the closest wall, navigates to it, climbs the wall, and maintains dynamic balance at the water level. EX1012, 4:62-5:2. If the user does not retrieve the robot within a “predetermined time period,” the robot “retreats to underwater” to continue cleaning. EX1012, 8:24-42. Importantly, Zhao’s timer is for docking/retrieval timeout-not for stopping a buoyancy control unit.

**E. Owen, EX1013**

Owen is directed to a pump for inflating household inflatable objects, particularly an air mattress. EX1013, 1:11-17. Owen addresses the problem that prior art pumps require user attention during inflation. EX1013, 1:17-19 (“Until now, however, these pumps generally require the user to hold an inflate or deflate button until the respective inflation or deflation has completed”). Owen’s solution is a timer-based automatic shutoff that allows a user to start a furniture inflation process without requiring the user to remain with the pump as the furniture inflates. EX1013, 2:1-2 (“The pump includes a timer that operates the pump after activation for a set period of time before automatically shutting off the pump”). Owen also discloses that “a pressure sensor (not shown) can be supplied that shuts the pump off automatically once a certain PSI (pounds per square inch) level is reached,” and that both the timer and pressure sensor may operate together as a “failsafe mechanism.” EX1013, 4:11-31.

#### **IV. OWEN IS NOT ANALOGOUS ART**

In order for a reference to be properly used in an obviousness determination under 35 U.S.C. § 103, the reference must be analogous art to the claimed invention. *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004). A reference is analogous art if (1) it is from the same field of endeavor as the claimed invention regardless of the problem addressed, or (2) it is reasonably pertinent to the problem faced by the inventor. *Id.* Owen fails both prongs.

##### **A. Owen is not from the Same Field of Endeavor as the Claimed Invention**

When determining whether a prior art reference meets the “same field of endeavor” test for analogous art, the primary focus is on what the reference discloses. *Bigio*, 381 F.3d at 1325. The ’196 patent “relates to the field of underwater robots, and in particular to a controllable sinking and floating swimming pool robot and a sinking and floating control method for a swimming pool robot.” EX1001, Abstract, 1:8-11. Owen, on the other hand, discloses various embodiments “directed to a pump for inflatable support systems having a mechanism for automatically shutting off the pump after inflation.” EX1013, 1:30-32. These fields are completely different. As Petitioner’s expert opined, the fields are “household bedding [i.e., Owen’s air mattress] versus aquatic robotics [i.e., the claimed invention].” EX1003, ¶293.

Petitioner acknowledges that Owen’s field is *not* directed to aquatic robots (as Petitioner’s expert broadly characterizes the claimed invention’s field).

Petition, 24 (“Owen’s embodiment concerns an inflatable mattress, it *explicitly applies to ‘an inflatable mattress or other inflatable object.’*”) (italics added, bold text in the original). The Petition’s emphasis of “other inflatable object” does not magically convert Owen’s *land-based* pump for a household mattress into an aquatic/underwater robot, let alone a controllable sinking and floating swimming pool robot and a sinking and floating control method for a swimming pool robot.

Moreover, the Petition (at 24) stretches the meaning of “other inflatable object” to “a broader technical field encompassing control of air pumps, bladders, and automatic shutoff mechanisms,” is misplaced and mischaracterizes the field of the claimed invention (i.e., underwater robots, particularly controllable sinking and floating swimming pool robots and a sinking and floating control method for a swimming pool robot).

The Petition goes so far as to allege that the differences between “household bedding [i.e., an air mattress] versus aquatic robotics—is superficial.” Pet. at 24; EX1003, ¶293. In doing so, the Petition relies on Dr. Cowan to bridge the large gap between the ’196 patent’s complex automated underwater technology and a “household” air mattress. He incredulously compares the differences between

Owen and the claimed invention as the difference between a toothbrush reference and a hairbrush reference. EX1003, ¶293.

Moreover, Dr. Cowan cites to *no* evidence for his conclusions on this issue, which is a clear instance of “gap filling.” This is improper. *Xerox Corp. v. Bytemark, Inc.*, IPR2022-00624, Paper 9, p. 15 (“Dr. Jones does not cite to any additional supporting evidence or provide any technical reasoning to support his statement. Thus, the cited declaration testimony is conclusory and unsupported, adds little to the conclusory assertion for which it is offered to support, and is entitled to little weight. See 37 C.F.R. § 42.65(a) (‘Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.’)”).

In addition, the Patent Office’s classification system confirms that the claimed invention and Owen are in different fields. Specifically, the international patent classifications for the ’196 patent are:

| <b>International Patent Classification</b> | <b>Description</b>                                                                                                                                                             |
|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B63G 8/24                                  | Underwater vessels adapted for special purposes, e.g. unmanned underwater vessels; Equipment specially adapted therefor, e.g. docking stations unmanned autonomously operating |
| B25J 3/00                                  | Manipulators of leader-follower type, i.e. both controlling unit and controlled unit perform corresponding spatial movements                                                   |

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| <b>International Patent Classification</b> | <b>Description</b>                                                                                                                             |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| B63G 8/00                                  | Underwater vessels adapted for special purposes, e.g. unmanned underwater vessels; Equipment specially adapted therefor, e.g. docking stations |
| E04H 4/16                                  | Self-propelled cleaners                                                                                                                        |
| G05D 1/467                                 | Control of position or course in three dimensions for movement inside a confined volume, e.g. indoor flying                                    |
| G05D 105/10                                | Specific applications of the controlled vehicles for cleaning, vacuuming or polishing                                                          |
| G05D 107/00                                | Swimming pools                                                                                                                                 |

EX1001, cover page section (51); B63G 8/24 (2006.01), B25J 3/00 (2006.01), B63G 8/00 (2006.01), E04H 4/16 (2006.01), G05D 1/467 (2024.01), G05D 105/10 (2024.01), G05D 107/00 (2024.01).

As can be seen, these classifications similarly indicate that the claimed invention's relevant field pertains to controllable underwater vessels adapted for special purposes including autonomous control for cleaning and or vacuuming, which is consistent with the '196 patent's description of the field as shown above. Owen is unrelated to any of these. Indeed, Owen's international patent classification is A47C 27/08 (EX1013, cover page section (51)), which corresponds to "Fluid mattresses of pneumatic type with non-manual inflation, e.g. with electric pumps." A47C 27/08 (2006.01).

Accordingly, Owen is not from the same field of endeavor as the '196 patent, failing the first *Bigio* test

**B. Owen is not Reasonably Pertinent to the Particular Problem with which the Inventor is Involved**

Owen also fails the second *Bigio* test, which requires that prior art must be “reasonably pertinent” to the problem faced by the inventor. *Bigio*, 381 F.3d at 1325. Nothing in Owen is “reasonably pertinent” to the claimed invention.

The ’196 patent describes the limitations of the prior art at the time as:

The existing sinking and floating control method for the swimming pool robots realizes floating or sinking by changing a quality of the swimming pool robots themselves through water absorption and drainage, and *the whole sinking and floating process takes a long time, resulting in a decrease in the working efficiency of the swimming pool robots.*

EX1001, 1:27-34 (emphasis added). In other words, the inventors of the ’196 patent sought to provide a solution to conventional swimming pool robots that controlled their buoyancy by absorbing water to sink and draining water to float, i.e., “changing a quality of the swimming pool robots themselves through water absorption and drainage.” *Id.* This water-intake/discharge approach was slow because absorbing and then subsequently draining water, enough to cause the robot to sink and float, takes significant time, thereby decreasing the robot’s working efficiency. The improvement provided by the ’196 patent is a change from a water-intake/discharge buoyancy control system to a gas-intake/discharge buoyancy

control system. This shift enabled a much faster transition between sinking and floating states because, as a POSITA understands, air is far less dense than water and can be moved more quickly. EX2001, 370 (Table 12.1 Densities of Some Common Substances showing air having a density of  $1.20 \text{ kg/m}^3$  and water having a density of  $1.00 \times 10^3 \text{ kg/m}^3$ ).

Owen's inventors sought to solve a completely different problem; namely, providing a means that allows a user to start a furniture inflation process without requiring the user to remain with the pump as the furniture inflates. EX1013, 1:16-23. For example, Owen provides:

Pumps are known in the art and are used to inflate items of furniture such as air mattresses and beds, which usually contain at least one air bladder. Until now, however, these pumps generally require the user to hold an inflate or deflate button until the respective inflation or deflation has completed. Other pumps may require that the inflation or deflation process be terminated by manually pressing a switch or knob on the pump, else the pump motor would continue to pump and possibly burn out. In either case, *a user cannot simply begin the inflation or deflation process and leave the pump unattended to let the process finish.*

EX1013, 1:16-23 (emphasis added).

A POSITA working on faster buoyancy control for an autonomous underwater robot would not logically consult air mattress inflation technology. The

problems are unrelated: one concerns autonomous robotic state management in an underwater environment; the other concerns freeing a user from babysitting a household appliance. Owen's timer exists simply because the user leaves and is not there to stop the inflation; the '196 Patent's timer exists to: (1) make the floating and sinking more efficient and (2) protect the device's hardware by using a better mechanism (air-intake/discharge v. water-intake/discharge). The inventors of the claimed invention were not concerned about removing a user-interaction (Owen's problem) because they were addressing a problem that was occurring with devices that were already automated in the first place.

Accordingly, Owen is not "reasonably pertinent" to the problem faced by the inventors of the '196 patent's claimed invention, failing the second *Bigio* test.

\* \* \*

Therefore, Owen is not analogous art to the claimed invention of the '196 patent and therefore is not proper prior art for the Petition's obviousness challenges in grounds 1-4.

## **V. CLAIM CONSTRUCTION**

The Petition is deficient for the reasons explained in subsequent sections regardless of whether the Board adopts any of Petitioner's proposed constructions. Claim construction therefore is not a prerequisite for determining that the Petition does not raise a reasonable likelihood of showing any claims are invalid. As such,

and for purposes of this preliminary response only, Patent Owner adopts Petitioner's proposed constructions without prejudice. Nevertheless, Patent Owner submits that each of Petitioner's proposed constructions are deficient for at least the following reasons.

Petitioner alleges that each of "sinking and floating control unit," "waterline detection unit," "posture detection unit," "outlet water detection subunit," "proximity waterline detection subunit," and "inflation and deflation subunit" are subject to §112(f). However, Petitioner fails to provide a proper construction under this section. Notably, Petitioner only identifies the alleged structure for each limitation without specifying the corresponding function. As a result, Petitioner's proposed claim constructions are incomplete and should not be adopted.

The remaining terms can be afforded their plain and ordinary meaning. *See Phillips v. AWH Corp.*, 415 F.3d 13030 (Fed Cir. 2005) (en banc). Patent Owner reserves the right to fully proffer its own constructions for any claim terms in its Patent Owner's Response under 37 C.F.R. § 42.220 should post grant review be instituted.

**VI. GROUND 1: PETITIONER HAS NOT ESTABLISHED A REASONABLE LIKELIHOOD OF SUCCESS THAT CLAIMS 1-7, 9-11 AND 13-19 ARE OBVIOUS OVER GUO, ZHAO AND OWEN**

As discussed above, Owen is non-analogous art to the claimed invention of the '196 patent. For this reason alone, Ground 1 is deficient. Nevertheless, should

the Board consider Owen analogous, the Petition still fails on multiple accounts as addressed below.

**A. Wang fails to disclose limitation [1g]**

Petitioner alleges that Wang alone discloses this limitation. Pet., 34-36.

Petitioner’s arguments are flawed for at least the following reasons:

**1. Petitioner Mischaracterizes Wang’s “Gas Volume Threshold”**

The Petitioner fundamentally mischaracterizes Wang’s “gas volume threshold.” Wang discloses three motion states with corresponding gas volumes:

| <b>Motion State</b>                               | <b>Gas Volume</b>                                       |
|---------------------------------------------------|---------------------------------------------------------|
| First motion state (bottom cleaning) <sup>1</sup> | Second volume (low gas, negative buoyancy) <sup>2</sup> |

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<sup>1</sup> EX1005, ¶68 (“a first motion state is defined as a state in which the cleaning device 10 moves on the bottom wall 401, or an angle between the bottom wall 401 and an overall direction of the cleaning device 10 is less than 90° and the cleaning device 10 is away from the liquid surface 30”).

<sup>2</sup> EX1005, ¶122 (“When the cleaning device 10 is in the first motion state, there is a second volume of the gas in the buoyancy cavity 5111”).

| Motion State                                     | Gas Volume                                              |
|--------------------------------------------------|---------------------------------------------------------|
| Second motion state (wall cleaning) <sup>3</sup> | Gas volume threshold (neutral buoyancy) <sup>4</sup>    |
| Third motion state (floating) <sup>5</sup>       | First volume (high gas, positive buoyancy) <sup>6</sup> |

Wang expressly disclose that “[t]he gas volume threshold is a value *between* the second gas volume and the first gas volume.” EX1005, ¶122. The gas volume threshold provides “a balanced force...in the vertical direction” so that “the

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<sup>3</sup> EX1005, ¶68 (“A second motion state is defined as a state in which the cleaning device 10 moves on the side wall 402, or the overall direction of the cleaning device 10 is substantially parallel to the side wall 402”).

<sup>4</sup> EX1005, ¶122 (“The gas volume threshold is a value between the second gas volume and the first gas volume.”).

<sup>5</sup> EX1005, ¶68 (“A third motion state is defined as a state in which the cleaning device 10 moves on the liquid surface 30, or the cleaning device 10 is at least partially exposed at the liquid surface 30, or the cleaning device 10 is entirely located under the liquid surface 30 and close to the liquid surface 30.”).

<sup>6</sup> EX1005, ¶122 (“When the cleaning device 10 is in the third motion state, there is a first volume of the gas in the buoyancy cavity 5111.”).

cleaning device can be attached to the wall of the pool in the vertical direction and better clean the wall of the pool.” EX1005, ¶122. Accordingly, Wang’s gas volume threshold corresponds to neutral buoyancy for *wall climbing*. But limitation [1g] recites the “floating working state,” meaning that the robot is floating and therefore has a positive buoyancy -- neutral buoyancy for wall climbing (Wang) is not positive buoyancy for floating (limitation [1g]).

## **2. Wang Routinely Exceeds the Gas Volume Threshold**

Petitioner alleges that 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.” Pet., 34. This is entirely incorrect as Wang expressly states that the gas volume threshold is routinely exceeded. EX1005, ¶122 (“The gas volume threshold is a value between the second gas volume and the first gas volume.”), ¶68 (“a first motion state is defined as a state in which the cleaning device 10 moves on the bottom wall 401, or an angle between the bottom wall 401 and an overall direction of the cleaning device 10 is less than 90° and the cleaning device 10 is away from the liquid surface 30”), ¶68 (“A third motion state is defined as a state in which the cleaning device 10 moves on the liquid surface 30, or the cleaning device 10 is at least partially exposed at the liquid surface 30, or the cleaning device 10 is entirely located under the liquid surface 30 and close to the liquid surface 30.”), ¶122

(“When the cleaning device 10 is in the third motion state, there is a first volume of the gas in the buoyancy cavity 5111”), ¶122 (“When the cleaning device 10 is in the first motion state, there is a second volume of the gas in the buoyancy cavity 5111.”). Wang’s floating state (third motion state) requires a first volume, which Wang expressly states is a gas volume *greater than* the gas volume threshold. If the pump stopped at the gas volume threshold (as the Petitioner’s inherency theory suggests), the robot would only achieve neutral buoyancy for wall climbing and would not be able to achieve a gas volume sufficient to enter the floating working state as required by limitation [1g].

Even the graph relied upon by Dr. Cowan shows that the threshold is exceedable:

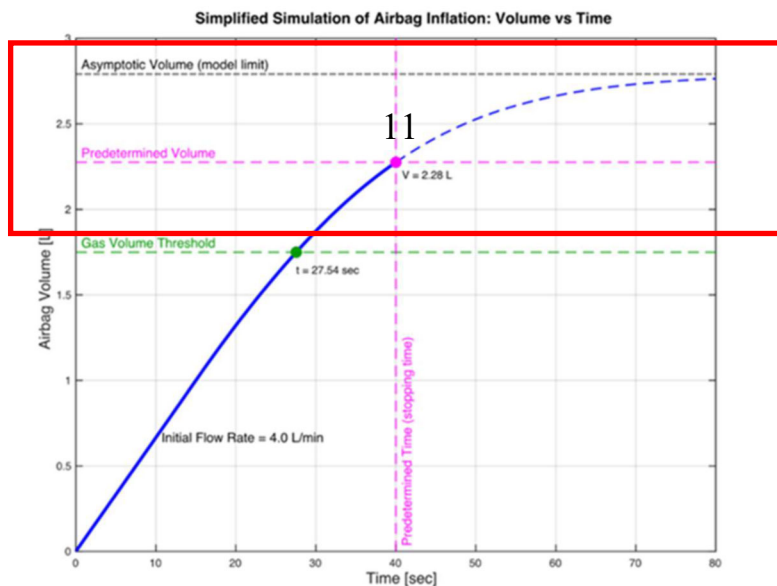


Fig. 1 of EX1021

EX1003, ¶274 (red box added).

Moreover, the gas volume threshold certainly is not used to “prevent overinflation or damage to the buoyancy cavity” since the gas volume threshold is exceeded every time the robot transitions from the wall climbing state to the floating state. EX1005, ¶122 (“The gas volume threshold is a value between the second gas volume and the first gas volume.”), ¶281 (“The first motion state or the third motion state may be a state of the filtering assembly 710 when the cleaning device 10 cleans the bottom of the pool or the water surface” and “The first motion state or the third motion state is different from the second motion state”), ¶122 (“When the cleaning device 10 is in the third motion state, there is a first volume of the gas in the buoyancy cavity 5111”), ¶122 (“When the cleaning device 10 is in the first motion state, there is a second volume of the gas in the buoyancy cavity 5111.”). Therefore, because Wang’s “gas volume threshold” does not *necessarily* result in the pump stopping operation as alleged by the Petition, Petitioner’s inherency argument must fail. *In re Rijckaert*, 9 F.3d 1531, 1534 (Fed. Cir. 1993) (“The fact that a certain result or characteristic ***may occur*** or be present in the prior art is not sufficient to establish the inherency of that result or characteristic.”) (emphasis added).

**3. Petitioner Incorrectly Assumes a Roughly Constant Flow Rate in its Inherency Argument**

Petitioner further alleges that Wang’s “gas volume threshold” inherently requires the pump to stop operating after a predetermined time because, according to Dr. Cowan, “for a pump operating at a roughly constant flow rate ( $Q$ ), the inflated volume ( $V$ ) increases linearly with time ( $t$ ) –  $V \approx Q \times t$ .” Pet., 21; EX1003, ¶¶271-272. Dr. Cowan cites to *no* evidence for his conclusions on this issue, which is another clear instance of improper “gap filling.” *Xerox Corp.*, IPR2022-00624, Paper 9, p. 15 (“Dr. Jones does not cite to any additional supporting evidence or provide any technical reasoning to support his statement. Thus, the cited declaration testimony is conclusory and unsupported, adds little to the conclusory assertion for which it is offered to support, and is entitled to little weight. See 37 C.F.R. § 42.65(a) (‘Expert testimony that does not disclose the underlying facts or data on which the opinion is based is entitled to little or no weight.’)). Petitioner then concludes that “a POSITA would readily select a predetermined inflation time that ensures the airbag exceeds the minimum buoyance requirement (the ‘Gas Volume Threshold’) while remaining below its pressure limit.” Pet., 35. Patent Owner disagrees.

Petitioner’s also argument fails because it is based on an assumption that the flow rate for an underwater robot is constant (“constant flow rate ( $Q$ )” in the above

equation). Petitioner's theory does not, however, account for backpressure, water temperature, ambient temperature, and depth of the robot in the water. For example, a POSITA would understand that pump flow rate varies with backpressure, i.e., as the buoyancy cavity inflates, internal pressure increases which results in a reduction of pump flow rate. Dr. Cowan acknowledges that backpressure results in a non-constant flow rate, but chooses to ignore this in his discussion at paragraphs 273-274. EX1003, ¶272 ("As the airbag nears its maximum capacity, the internal pressure rises due to membrane tension and hydrostatic head. This increased back-pressure causes the pump's effective flow rate to decay toward zero"). Taken together, Petitioner's theory assumes a deterministic relationship between time and volume that only exists in ideal conditions.

Accordingly, for at least the foregoing reasons, Petitioner failed to show that Wang discloses limitation [1g].

**B. Wang in view of Owen fails to disclose limitation [1g]**

In the alternative, Petitioner alleges that Wang in view of Owen discloses this limitation. Pet., 34-36. As discussed above, Owen is non-analogous art to the '196 patent. For this reason alone, Petitioner's reliance on Wang in view of Owen is deficient. Nevertheless, should the Board consider Owen analogous art, Petitioner's arguments are similarly flawed.

Petitioner alleges that “[i]ntegrating Owen’s timer circuit into Wang’s buoyancy-control framework would have been a routine *substitution* of known control methods.” Pet., 22. Petitioner does not expressly state what Owen’s timer circuit would replace, but given the context, it is clear that Petitioner’s position is that Owen’s timer circuit would replace Wang’s gas-volume threshold. Pet., 22 (“a POSITA would recognize that Wang’s gas-volume threshold corresponds to a predetermined-time inflation control to prevent overfilling and maintain safety”). As discussed above, Wang’s gas-volume threshold is used to maintain the robot in a wall climbing position – not a floating working state. Owen fails to compensate for this deficiency, meaning that the combination does not render limitation [1g] obvious. Accordingly, at best, substituting Owen’s timer circuit for Wang’s gas-volume threshold would only result in a timer that activates when the Wang’s robot enters a climbing state and must be exceeded for Wang’s robot to subsequently transition from the climbing state to the floating state. But this teaching fails to compensate for Wang’s deficiencies, meaning that the combination does not render limitation [1g] obvious.

Therefore, Petitioner has not established a reasonable likelihood of success in Ground 1.

**VII. GROUND 2: PETITIONER HAS NOT ESTABLISHED A REASONABLE LIKELIHOOD OF SUCCESS THAT CLAIMS 8 AND 12 ARE OBVIOUS OVER WANG, ZHAO, OWEN AND GUO**

Claims 8 and 12 are ultimately dependent on independent claim 1. By nature of this dependency, Ground 2 is deficient for reasons similar to Ground 1.

Therefore, Petitioner has not established a reasonable likelihood of success in Ground 2.

**VIII. GROUND 3: PETITIONER HAS NOT ESTABLISHED A REASONABLE LIKELIHOOD OF SUCCESS THAT CLAIMS 1-6, 10, AND 14-17 ARE OBVIOUS OVER ZHANG, ZHAO AND OWEN**

Petitioner relies on Zhang's statement that "a volume of the buoyancy cavity 1111 may be preset" to argue that Zhang discloses a volume threshold that inherently requires the pump to stop working after a predetermined time to prevent overinflation or damage to the buoyance cavity. Pet., 68. Using this as a backdrop, Petitioner relies upon the same assumption that Zhang discloses a constant flow rate of gas to achieve the "present volume." Pet., 68. Again, this theory fails because Dr. Cowan himself admits the formula's critical limitation that the flow rate of gas is not constant throughout the inflation process because of backpressure. EX1003, ¶453 ("A POSITA would understand that when an airbag is filled by a pump operating at a constant volumetric flow rate ( $Q$ ), and while back-pressure remains low (i.e., the bag is still compliant and far below its geometric or pressure limit), the volume ( $V$ ) of the airbag grows roughly linearly with time ( $t$ ")), ¶454

(“As the airbag nears its maximum capacity, the internal pressure rises due to membrane tension and hydrostatic head. This increased back-pressure causes the pump’s effective flow rate to decay toward zero, and consequently, the airbag’s volume asymptotically approaches a limiting value rather than increasing indefinitely.”).

Accordingly, because Petitioner has not shown that flow rate is constant, time does not reliably correspond to volume as alleged in the Petition on p. 68. As a result, a predetermined time cannot reliably achieve a predetermined volume as alleged by the Petitioner because the time-volume relationship is non-linear and varies with pressure conditions. EX1003, ¶67 (“A POSITA would understand that when an airbag such as that disclosed by Guo is filled by a pump operating at a constant volumetric flow rate ( $Q$ ), and while back-pressure remains low (i.e., the bag is still compliant and far below its geometric or pressure limit), the volume ( $V$ ) of the airbag grows *roughly linearly* with time ( $t$ ).”), ¶68 (“As the airbag nears its maximum capacity, the internal pressure rises due to membrane tension and hydrostatic head. This increased back-pressure causes the pump’s effective flow rate to decay toward zero”). Petitioner’s proposed combination of Zhang and Owen therefore fails for at least this additional reason.

Petitioner has not established a reasonable likelihood of success in Ground 3.

**IX. GROUND 4: PETITIONER HAS NOT ESTABLISHED A REASONABLE LIKELIHOOD OF SUCCESS THAT CLAIMS 1-8, 10-13 AND 15-19 ARE OBVIOUS OVER GUO, ZHAO AND OWEN**

First, Petitioner alleges that “Guo itself notes that the airbag material...requires protection against puncture,” citing EX1010, ¶37, and therefore “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 amount of time to prevent overinflation and material stress.” Pet., 93. This completely mischaracterizes Guo. Instead, Guo’s Paragraph 37 states that the airbag is protected from *being punctured by foreign objects* through the use of a protective sleeve positioned over the airbag. EX1010, ¶37 (“A protective cover...is sleeved over the airbag 121....Since the material of the airbag 121 is relatively soft, the protective cover can effectively prevent the airbag 121 from being punctured by foreign objects.”).

Second, Petitioner alleges that because Guo emphasizes “precise control of gas content” in each airbag, a timer is inherently required. Pet., 93. This again is a mischaracterization of Guo and does not meet the requirements for showing inherency. Guo’s disclosure of “more precise control of the gas content in each airbag” refers to having individually controlled airbags rather than multiple airbags connected to a single inflation/deflation device. EX1010, ¶39 (“each airbag 121 is individually connected to an inflation/deflation device 122, and each

inflation/deflation device 122 independently controls the inflation or deflation of each airbag 121. This allows more precise control of the gas content in each airbag 121, and thus more precise control of the ascent or descent speed of the underwater cleaning robot.”). In other words, the precision referenced by Petitioner comes from independent control of each airbag so that the *speed* of the robot can be controlled better.

Third, Guo discloses a sealed internal gas circulation system that operates differently from open-air inflation systems. In particular, in Guo, the air comes from the *sealed driving cabin* inside the robot and not from the external atmosphere. EX1010, ¶19 (“Compared with the prior art, in the swimming pool cleaning robot of the present disclosure, the airbag is connected to the driving cabin via the inflation/deflation device, and the driving cabin of the swimming pool cleaning robot serves as the gas source for the floating and diving assembly.”), ¶19 (“When it is necessary to control the robot to surface, the inflation/deflation device draws gas from the driving cabin into the airbag. When it is necessary to control the robot to dive, the inflation/deflation device discharges gas from the airbag into the driving cabin.”). Therefore, Guo implements a closed-loop system in which gas is transferred between the airbag and the sealed driving cabin. This closed loop system is fundamentally different from an open-air system that Owen employs for air mattress inflation. Moreover, Petitioner’s alleged risk of

Guo's airbags overinflating is not feasible due to the existence of a finite amount of gas in Guo's closed-loop gas circulation system. Because no additional gas is created, the amount of gas inside Guo's system is finite. Therefore, Guo's system is not prone to overinflation like Owen's open-air mattress system. As such the combination of Guo, Zhao and Owen fails to teach at least limitation [1g].

Therefore, Petitioner has not established a reasonable likelihood of success in Ground 4.

**X. GROUND 5 – PETITIONER HAS NOT ESTABLISHED A REASONABLE LIKELIHOOD OF SUCCESS THAT CLAIMS 1-14 ARE INDEFINITE**

Petitioner alleges that “main control unit” is a means-plus-function limitation under §112(f) and that the specification does not adequately describe its structure. Pet., 112. This argument fails because “control unit” has a well-established structural meaning in the field of robotics and embedded systems.

“Control unit” connotes definite structure. Unlike abstract nonce words such as “module,” “mechanism,” or “element,” the term “control unit” has concrete structural meaning to engineers working in robotics. *See, e.g.,* EX2002, 112 (definition of “control unit”). A POSITA would immediately understand “control unit” to refer to a processor, microcontroller, or equivalent control circuitry.

Further, Petitioner concedes that “[i]f the Board declines to apply §112(f), ‘main control unit’ would at most refer to a generic processor/controller

performing the recited functions.” Pet., 114. This admission is fatal to the indefiniteness argument. If a POSITA understands “main control unit” to mean a processor or controller, then the term does connote structure. Petitioner cannot simultaneously argue that “main control unit” is structureless while admitting that a POSITA would understand it to mean a processor.

**XI. GROUND 6 – PETITIONER HAS NOT ESTABLISHED A REASONABLE LIKELIHOOD OF SUCCESS THAT CLAIM 4 IS INDEFINITE**

Petitioner alleges that “distance measure unit” is a means-plus-function limitation under §112(f) and that the specification does not adequately describe its structure. Pet., 114. This argument fails for the same reasons as Ground 5: “distance measurement unit” connotes definite structure to a POSITA, particularly when viewed in light of the teachings of the ’196 patent.

Further, the specification for “distance measurement unit” provides express structural examples. EX1001, 10:5-10 (“The distance measurement unit 50 may be configured by an ultrasonic distance measuring device, or the distance measurement unit 50 may be configured by a pressure measuring device.”). This disclosure identifies specific, concrete structures: ultrasonic distance measuring devices and pressure measuring devices. These are not abstract concepts—they are physical sensors with well-understood structural characteristics.

A POSITA in the field of robotics and autonomous systems reading the '196 patent would understand a “distance measurement unit” to refer to the well-known sensing devices disclosed therein (e.g., ultrasonic distance measuring devices and pressure measuring devices).

## XII. CONCLUSION

For each of the foregoing reasons, the PGR should not be instituted as to the requested grounds.

Dated: February 20, 2026

Respectfully submitted,

/ Gianni Minutoli /

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**CERTIFICATE OF COMPLIANCE**

I, Gianni Minutoli, certify that this paper complies with the type-volume limitation of 37 C.F.R. § 42.24 because it contains 7,481 words, excluding the parts of the paper exempted by 37 C.F.R. § 42.24(a).

Dated: February 20, 2026

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**CERTIFICATE OF SERVICE**

Pursuant to 37 C.F.R. § 42.6, I hereby certify that on February 20, 2026 the foregoing Patent Owner Preliminary Response was served via email on the following counsel of record for the Petitioner:

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