

Waldo Floats

1. System Overview

The Autonomous Vertical Profiler is a specialized, variable-buoyancy vehicle designed to execute precise depth-profiling missions. Operating independently of a main ROV tether during its sequence, the profiler utilizes a custom syringe-based ballast system to control its position in the water column. It features dual-core processing, cloud-based telemetry, and an autonomous dive sequence, making it a highly capable platform for data acquisition.

2. Mechanical Design & Variable Buoyancy

The core of the profiler's depth control relies on a Variable Buoyancy System. The system is designed to be naturally positively buoyant at the start of its mission.

Syringe Ballast System: The physical water intake is managed by two 20 mL syringes.

Actuation Mechanism: These syringes are driven by a linear actuator. The mechanical integration utilizes a custom 3D-printed frame and mounts.

Operation: The 3D-printed framing securely holds the top of the syringes, while the plungers are directly linked to the moving carriage of the linear actuator. As the actuator extends or retracts, it simultaneously pulls or pushes the plungers. Drawing water into the syringes increases the overall mass of the profiler, causing it to sink; expelling the water restores positive buoyancy, allowing it to rise.

To ensure safe operation, the profiler's electronics tube incorporates a passive mechanical failsafe to manage internal pressure. If internal pressure exceeds a safe threshold, the end cap is specifically engineered to deliberately yield and pop off, safely venting the system without violently rupturing the main hull.

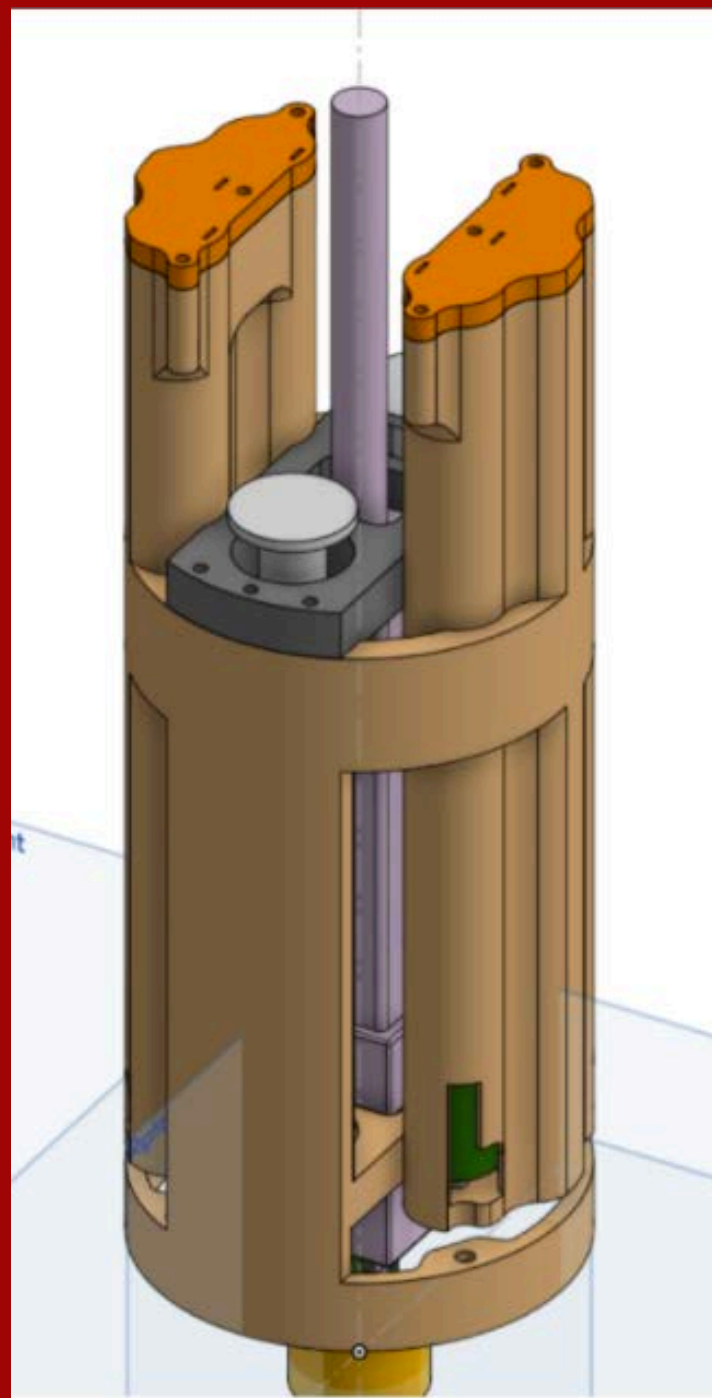


Photo of 3D CAD model

3. Electrical & Power Systems

The profiler's electrical architecture is strictly divided into logic and high-power circuits to ensure signal integrity and reliable motor operation.

Microcontroller: The brain of the system is an ESP32 microcontroller, chosen for its dual-core processing capabilities and integrated Wi-Fi.

Motor Control: A dedicated motor driver acts as the intermediary between the ESP32 and the linear actuator, handling the high-current demands required to overcome water pressure when adjusting the syringes.

Power Distribution: The system is completely untethered, powered by two onboard arrays of 9 and 3 NiMH individual battery cells

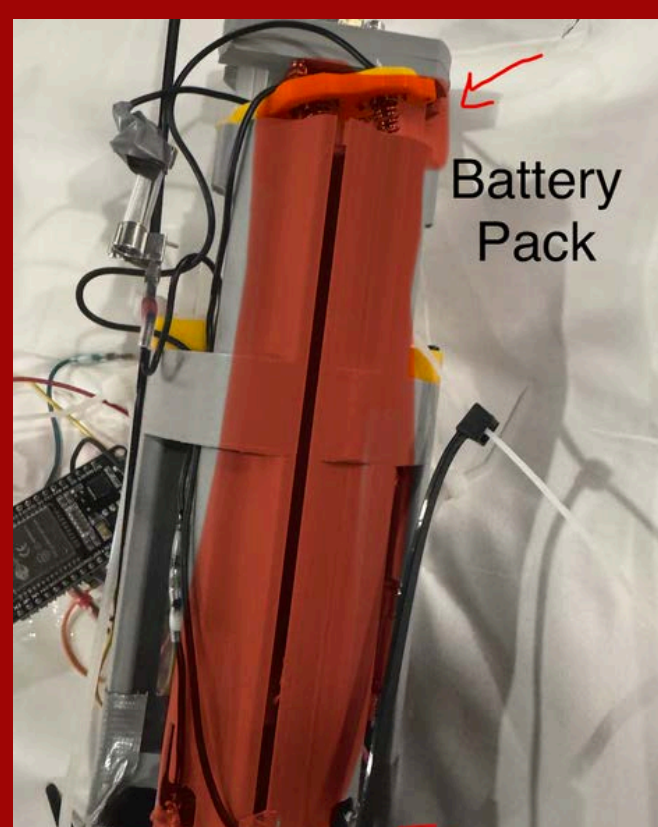


Photo of main battery pack

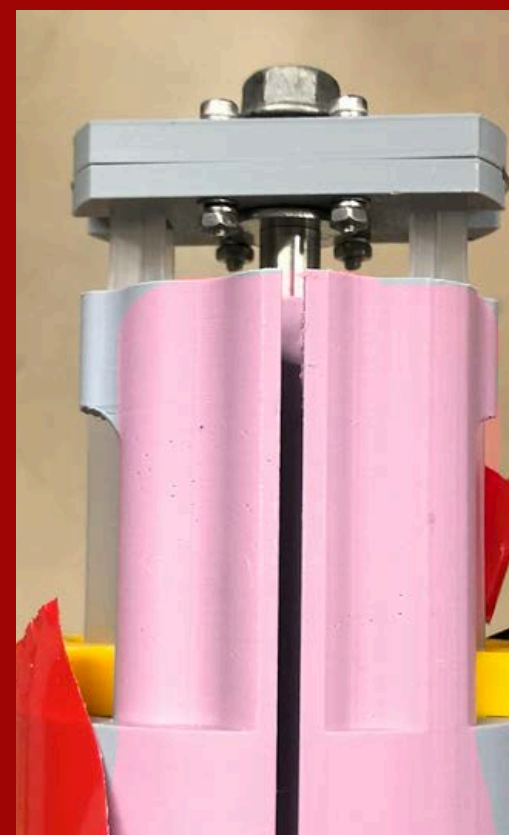


Photo of ESP battery pack

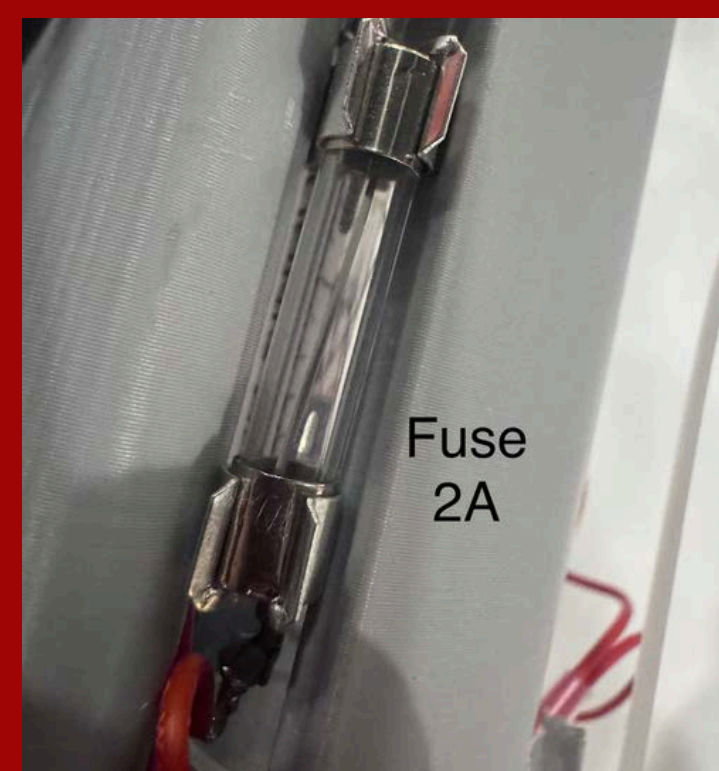


Photo of 2A fuse on positive side

All Photos taken by Natalie C.



Photo of housing

Battery Packs

The battery packs were designed as part of our 3D printed frame, firmly securing all 12 **NiMH batteries**, with 4 fuses within 5cm of the battery pack, keeping the current under 2 and 1 amps respectively and safely fulfilling the full load current needs and voltage requirement.

4. Software Architecture

To manage the complex requirements of simultaneous data collection and precise depth maintenance, the software is built on FreeRTOS (Real-Time Operating System). This allows the ESP32 to fully utilize its dual-core architecture by dividing critical tasks:

Core 0 (Data Acquisition): Dedicated entirely to sensor polling, gathering environmental results, and logging the data. This ensures that data collection occurs at a steady, uninterrupted rate regardless of motor activity.

Core 1 (Navigation & Control): Dedicated to calculating buoyancy requirements and controlling the linear actuator. It continuously monitors current depth and adjusts the water volume in the syringes to achieve or maintain target depths.

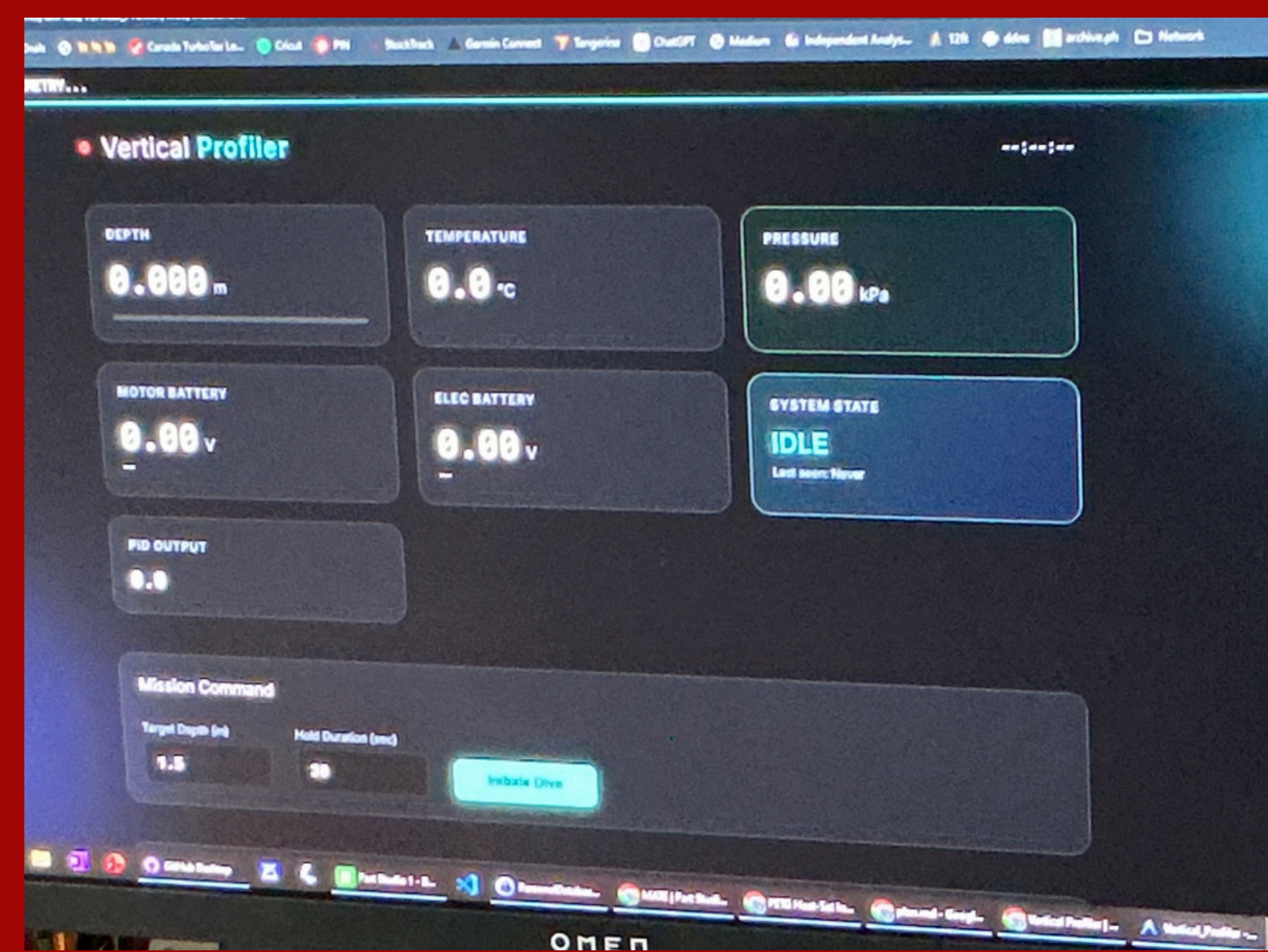


Photo of user interface taken by Natalie C.

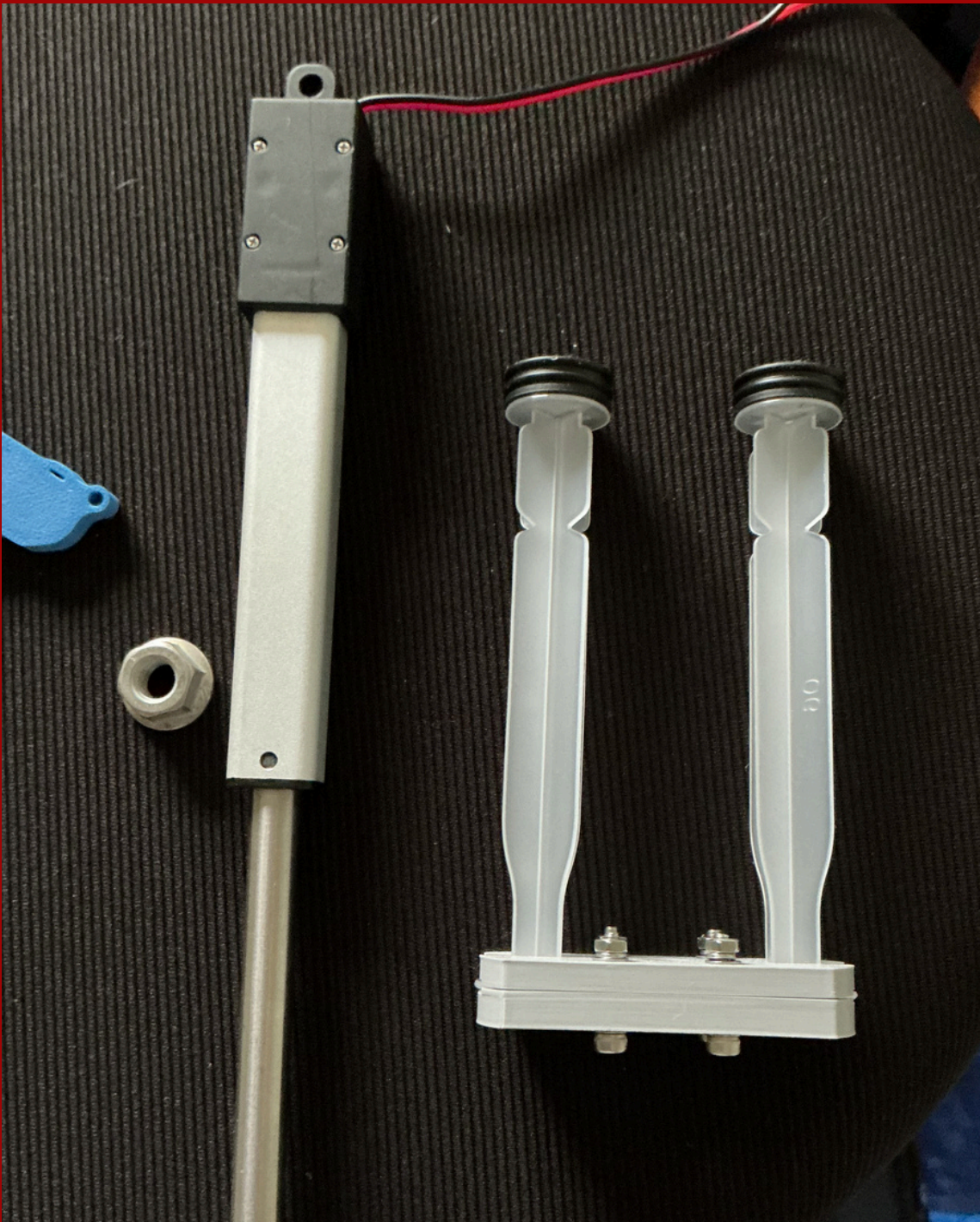


Photo of linear actuator and plunger model

5. Telemetry & User Interface

While the mission sequence operates autonomously, command and data transmission are handled remotely through a wireless local network hosted directly by the ESP32. The ESP32 hosts a dedicated Wi-Fi network that allows the operator computer to connect directly to the profiler once surfaced. A custom local web dashboard is accessed through the ESP32 Wi-Fi connection, allowing operators to monitor system status and view collected profiling data in real time.

6. Autonomous Mission Sequence

Once the “initiate” command is sent from the local web dashboard to the ESP32 through the profiler’s dedicated Wi-Fi connection, the profiler executes a hardcoded autonomous dive profile without requiring further operator input.

- Descent: The actuator draws water into the syringes to increase mass and initiate descent to a target depth of 2.5 meters.
- Bottom Loitering: Core 1 dynamically adjusts the syringe ballast system to maintain the 2.5 m depth for 30 seconds while Core 0 continuously collects and logs sensor data.
- Ascent to Mid-Water: The actuator expels water from the syringes, increasing buoyancy until the profiler rises to a depth of 40 cm.
- Mid-Water Loitering: The profiler maintains the 40 cm depth for 40 seconds to perform a secondary environmental data collection phase.
- Surface Return & Transmission: The profiler expels the remaining ballast water and returns fully to the surface. Once surfaced, the ESP32 reconnects to the operator computer through its hosted Wi-Fi network and wirelessly transmits all logged profiling data to the local web dashboard.



Photo of internal design

SID

