**Hackley Whirlpool** - Non-ROV Device: The Float

**Specifications:**

The Hackley Whirlpool team has developed a specialized float known as the CT (Cylinder Thing), which is tailored to complement the functionality of our remotely operated vehicle (ROV). The CT's design is crafted to fit perfectly within the ROV's primary gripper, ensuring that operators can deploy the float with ease and precision. This strategic design consideration not only facilitates straightforward deployment but also significantly cuts down on production costs. Consequently, it allows for the construction and deployment of multiple CT units as needed, enabling widespread data collection across diverse marine environments. The straightforward, cost-effective design of the CT is a testament to its practicality and utility in large-scale underwater research.

Our float uses syringes in the float to expel/pull in water, effectively decreasing or increasing the density of the device. We created it to be almost completely neutrally buoyant so that this change in density is enough to induce floating or sinking, respectively. A stepper motor is utilized to actuate water-tight plungers which either draws water into or pushes water out of the three syringes in the float (see Fig. 1).
The plunger of the syringe is connected to a servo motor, which in turn is connected to an Arduino Uno that is programmed to rotate and move the syringe plunger vertically. By moving the plunger vertically, water can be drawn into or out of the syringe, which controls the buoyancy of our float “Cylinder_thing.” When water is drawn into the syringe, the float device becomes more buoyant and rises in the liquid. Then, when water is expelled from the syringe, the float device becomes less buoyant and sinks into the liquid. To counteract the buoyancy of the PVC, we employ metal rods in order to achieve neutral buoyancy. We use caulk to waterproof our float.

"Cylinder_thing" is designed to sink and float autonomously, enabling it to survey multiple layers of the water column with minimal human intervention. This device is not only cost-effective but also highly efficient in collecting data from different depths of the water column. Since our float functions as a *buoyancy engine* rather than any motors, very little power is used, and the entire apparatus can be powered by a single 9V battery. Finally, the float communicates wirelessly with the main robot and the base station when above the water level; because of this, the float may be used relatively far from the robot and collect data from much deeper than a tether would allow. Once deployed, the CT begins its mission by efficiently transmitting crucial environmental data over a dedicated 2.4 GHz WiFi network. It provides real-time updates, including time from its onboard Real-Time Clock (RTC), depth data collected by a Bar-02 sensor, and other pertinent environmental metrics directly to the main ROV.

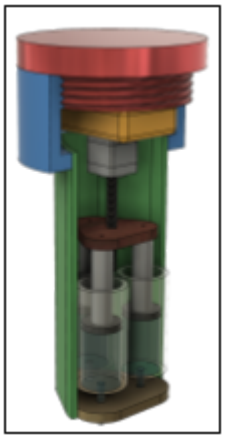

**Fig. 1** A rendering of the float cut out so the internal components are visible. The threading on the float cap ensures that any parts of the float outside of the syringe bodies are completely water tight. A rubber gasket (not pictured) is also used to maintain water-tightness. A microcontroller (pictured in yellow) is used to actuate the stepper motor and communicate with the base station when above water. The motor rotates the threaded bolt, which translates the syringe plungers, either drawing water in or out.

All safety requirements of ELEC-NRD-004 have been met as well. In our float, we used one 9V alkaline primary battery. The battery is mounted in a specialized electronics housing within the container, and a 5A fuse is connected directly to the battery. In addition, we have employed a 4 cm relief plug in our float so that pressure will be released if much is built up in the container.
While the CT may seem primitive when compared to the sophisticated Coastal Pioneer Array used in broader oceanic research, it plays an essential role in the localized monitoring of ocean health. This functionality positions the CT as an invaluable tool in our toolkit, offering a scalable and efficient solution for ongoing marine environmental monitoring efforts.