Non-ROV device

The float we designed and built has a total length of 62 cm and an maximal outer diameter of 16.5 cm. It´s main shape is given by the main body, a tube made of polymethyl methacrylate. The weight is about 7.2 kilograms. The construction inside this tube is platform based. The platforms contain the electrical devices, the motor and power supply and the buoyancy engine. The float's main body is waterproof sealed by turned aluminum end caps with ring seals. On the bottom end cap, a ballast container is attached. On the top end cap is a ball valve and a Wi-Fi antenna. The counterpartas ground station is shown via a notebook and a local webserver.

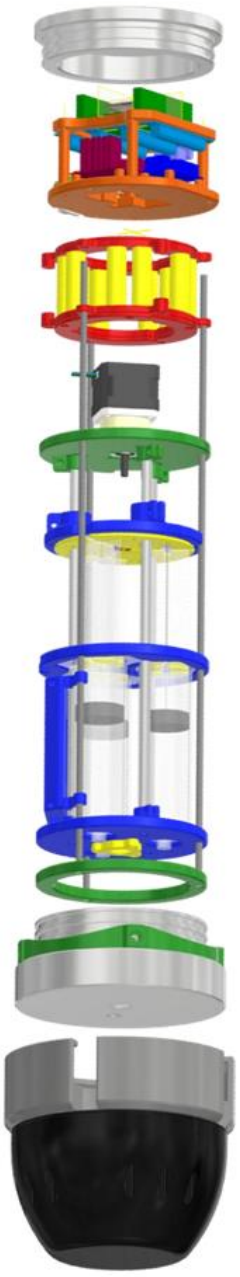

Figure 1: Exploded view of the Non-ROV device

To keep the float waterproof, two O-ring seals are installed on each end cap. Other openings from the inside of the float to the outside are the inlet and outlet of the buoyancy engine, to which hoses are connected to two of the three syringes, and the ball valve. This valve is opened before diving, and a vacuum pump is used to create a vacuum inside the float. This ensures that the end caps remain securely sealed to the tube.

On the upper platform, shown in orange, most of the electronics are housed. A reed switch serves as the main power switch, which is activated by a magnet attached to an adjustable ring on the outside. The core component is an ESP32, which runs the float's control system. Additionally, it serves as the interface to the ground station via a Wi-Fi signal. Several voltage converters supply all components with the correct operating voltages from the 12 V battery. The stepper motor is controlled by the ESP32 via a driver. A Balluff pressure sensor in the lower end cap measures the water pressure as relative pressure and transmits it as a current signal. After conversion into a voltage signal, this data is used by the ESP to control the buoyancy engine. A pressure sensor inside the float provides the reference value for the relative measurement. By determining the actual value, the control system can now drive the stepper motor to fill or empty the syringes.

To prevent mechanical damage, limit switches are installed at the upper and lower end positions to stop further movement. For additional safety, a humidity and temperature sensor transmits its readings to the ESP as well.

The platforms are fixed at the correct distance from each other using three threaded rods secured with nuts. The platform on which the stepper motor is mounted has a spindle connected to the syringe heads. The platform components are 3D-printed.

By moving the stepper motor, the syringes are either filled or emptied. The stepper motor is connected to a planetary gear with a ratio of 5:1. Due to the force of the water pressure, only two of the three syringes are filled with water in this configuration with the stepper motor.

The float's battery is arranged in a ring shape around the stepper motor. It is a 12 V battery composed of 10 NiMH cells connected in series, with a capacity of 2200 mAh. These cells were taken from a commercially available battery pack, separated, and reconfigured into a ring shape using a 3D-printed structure to connect them in series. All power-carrying cables have a cross-section of 0.75 mm² and are designed for a current of 5A at 12 V. A 5 A automotive fuse was installed accordingly for protection.

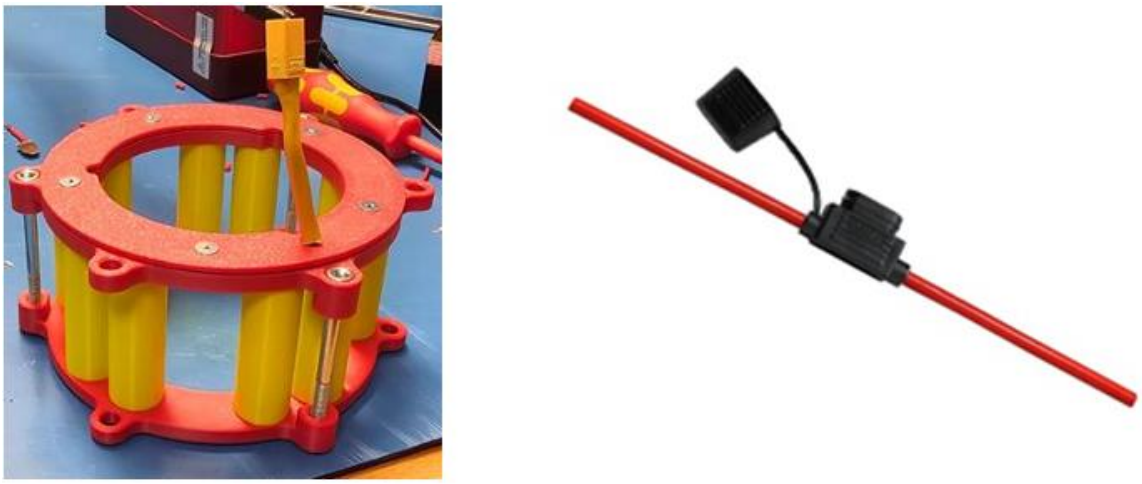

Figure 2: Picuture of the Batterypack (Left) and 5A Fuse (Right)

The float draws 250 mA at idle with all systems active, peaks at 550 mA during stepper motor startup, and operates at 330 mA during continuous use of the buoyancy engine. Communication with the float is established via Wi-Fi through a waterproof antenna connected to the onboard ESP32. Once submerged, the connection is lost.

Before diving, users connect to the ESP32-hosted web server to configure settings such as target pressure, buoyancy calibration, PID parameters, dataset name, and to start the dive. The float then adjusts its buoyancy to reach the set depth, collects measurement data, and resurfaces.

When the antenna is above water again, the Wi-Fi reconnects, and users can access the web server to download data. Pressure and depth are displayed graphically and in table form, with a log file available for download.