King AbdulAziz University - Saudi Arabia, Jeddah

RedSea Rovers

non-ROV device design

Introduction

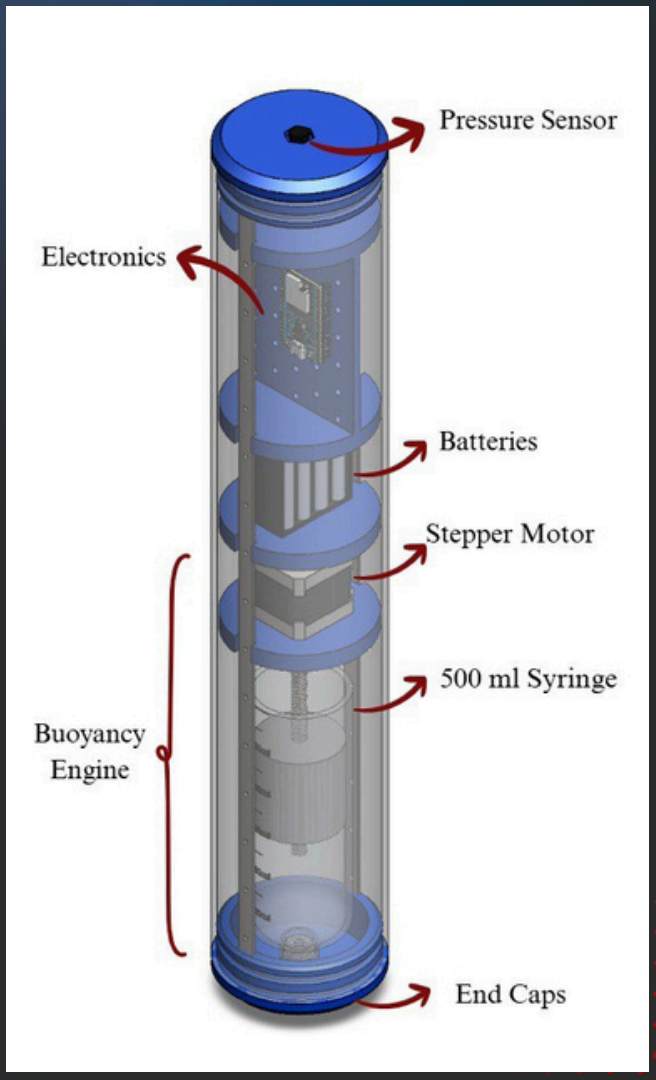
The RedSea Rovers Vertical Profiling Float is an autonomous underwater system designed to perform precise depth profiling for environmental monitoring. As part of Task 3, the float executes two full-depth cycles, leveraging an innovative buoyancy control mechanism to ascend and descend efficiently.

Mechanical

The vertical profiling float designed by RedSea Rovers is engineered to perform two complete depth profiles as part of Task 3. Buoyancy control is achieved through a stepper motor-driven system that manipulates water displacement inside a 500 mL syringe. The motor operates a threaded lead screw attached to a plunger, which, when moved, draws water in or expels it from the syringe—thereby modifying the float's buoyancy and enabling it to ascend or descend.

The entire mechanism is powered by eight AA batteries and controlled by an Arduino Nano ESP32 module. All electronics and mechanical components are enclosed within a 500 mm acrylic tube with a 90 mm diameter. Custom 3D-printed endcaps and internal components are secured and sealed using epoxy, providing both structural integrity and waterproofing while remaining cost-effective.

Upon deployment, the float initiates a controlled descent. It maintains communication with the surface station using wireless transceivers. Throughout its vertical profile, real-time depth data is transmitted using an integrated pressure sensor, supporting accurate and efficient environmental data collection.



Electrical

The float's internal electronics are centered around an ESP32 microcontroller, selected for its integrated Wi-Fi, energy efficiency, and multitasking capability. Serving as the system's central processor, the ESP32 receives input from onboard sensors and issues command signals to the actuator system. It also supports real-time data acquisition and wireless communication with the topside base station.

A stepper motor is used to actuate the profiling mechanism, moving an internal plunger to alter the float's buoyancy. This motor is powered and controlled through a dedicated stepper driver, which receives both control signals from the ESP32 and electrical power from the main supply. The driver ensures smooth, precise operation of the motor during ascent and descent sequences.

A real-time clock (RTC) module is connected to the ESP32 through digital signal lines to provide accurate timing and data logging. A pressure sensor is also integrated into the system, delivering continuous depth measurements to the ESP32 for real-time processing and transmission.

All electrical components are powered by an 8AA battery pack.