TEAM 3

Aquatifliers

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Problem Definition

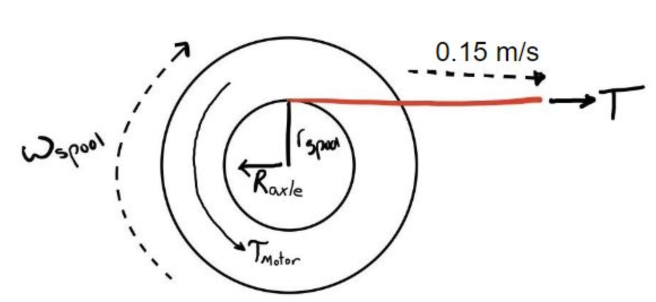
- Quadrotors capable of aerial and aquatic traversal may improve the efficacy of critical tasks like disaster response, environmental monitoring, and search and rescue missions.
- Dr. Miao Yu, Dr. Yantian Zha, and PhD candidate Xiaomin Lin realized the potential of this technology for underwater research and proposed the idea.
- Our device allows for an increase in operational complexity without the added complexity of waterproofing an aerial drone for underwater flight.
- We designed the Aquatiflier, an adapter for the SwellPro FD2 Fisherman MAX quadrotor, which carries and deploys an Underwater Remotely Operated Vehicle (UROV).

Design Calculations & Analysis

Motor Specification

Given
- $L_{Tether} = 9.1$ m
- $t_{Gather} = 1$ minute
- $F_{Drag} = 2.2$ N
- $F_{Spring} = 6.5$ N
- $r_{Outer} = 40$ mm
- $r_{Inner} = 20$ mm

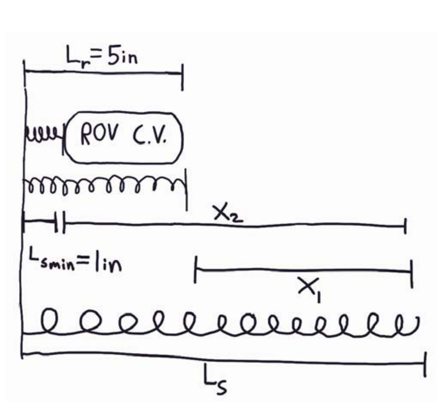
Results
- $\omega_{Spool\ Max} = 73$ rpm
- $T_{Drag} = 76$ N-mm
- $T_{Spring} = 271$ N-mm

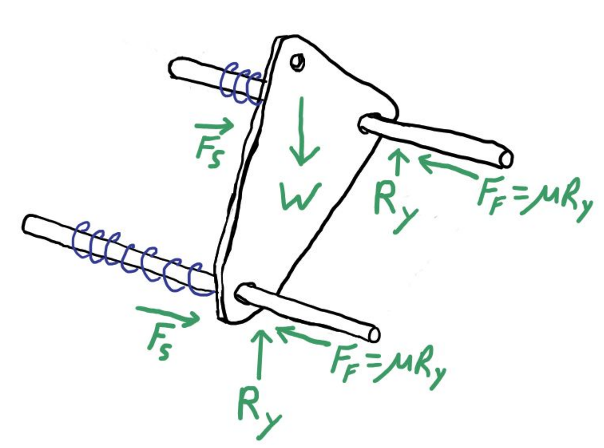


Deploy Spring Specification

Given
- $W_{ROV} = 19.6$ N
- $\mu_{Kinetic} = 0.36$
- $F_S = k\,x_1$
- $F_f = \mu_{Kinetic} R_y$
- $L_{s\,min} + x_2 = L_S$

Results
- $\Sigma F_x = 0 = 2F_{spring} - 2F_f$
  - $\mathbf{F_{spring} = F_f = 3.25\ N}$





Battery Specification

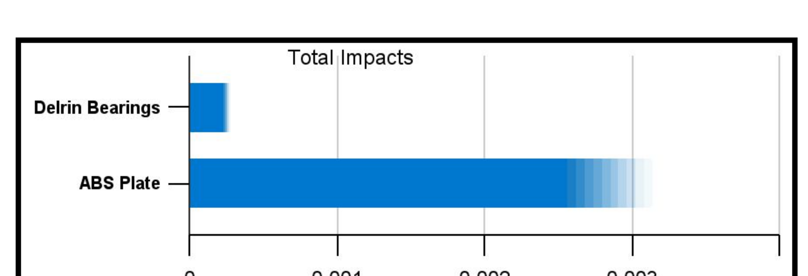
Component	Max Power (W)	Voltage (V)	Max current (A)
Raspberry Pi 3B+	12.5	5	2.5
Radio	0.08	3.2 - 5.5	0.016
Tether Interface	2.5	5, 7 - 28	~
Spool motor	2.2	12	0.18
Feeder servo	1.0	4.8 - 6	0.2
Latch servo	1.0	4.8 - 6	0.2
			1.16

SwellPro Battery Life - **28 Minutes**
Minimum Capacity to Meet Runtime at Max Power Usage - **750 mAh**

Replaceable Wear Components

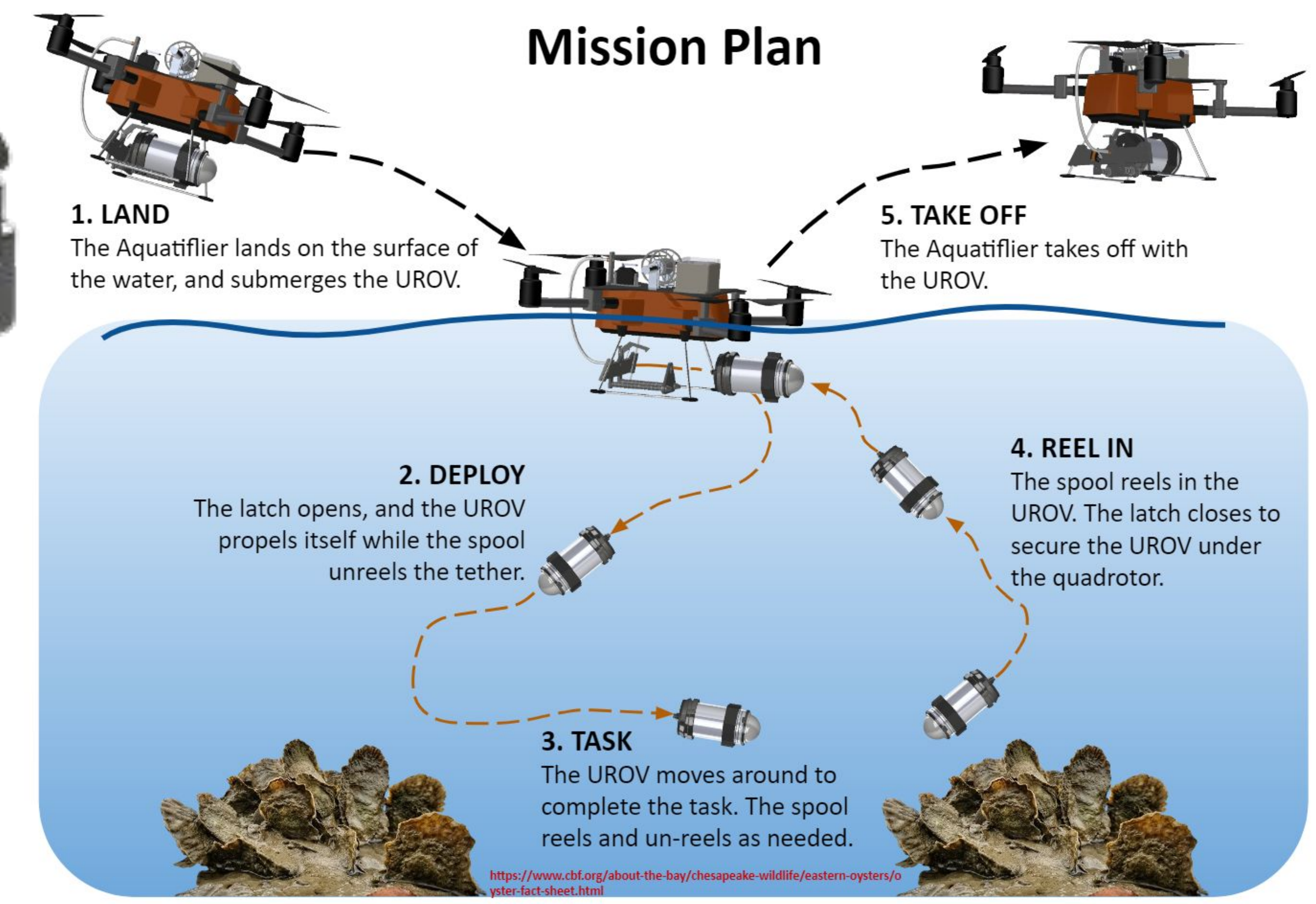
Our design has a sliding interface between the deploy rods and the deploy slider. If the deploy slider wears out, the entire part will need to be replaced. If the bearings wear out, only those parts will need to be replaced.

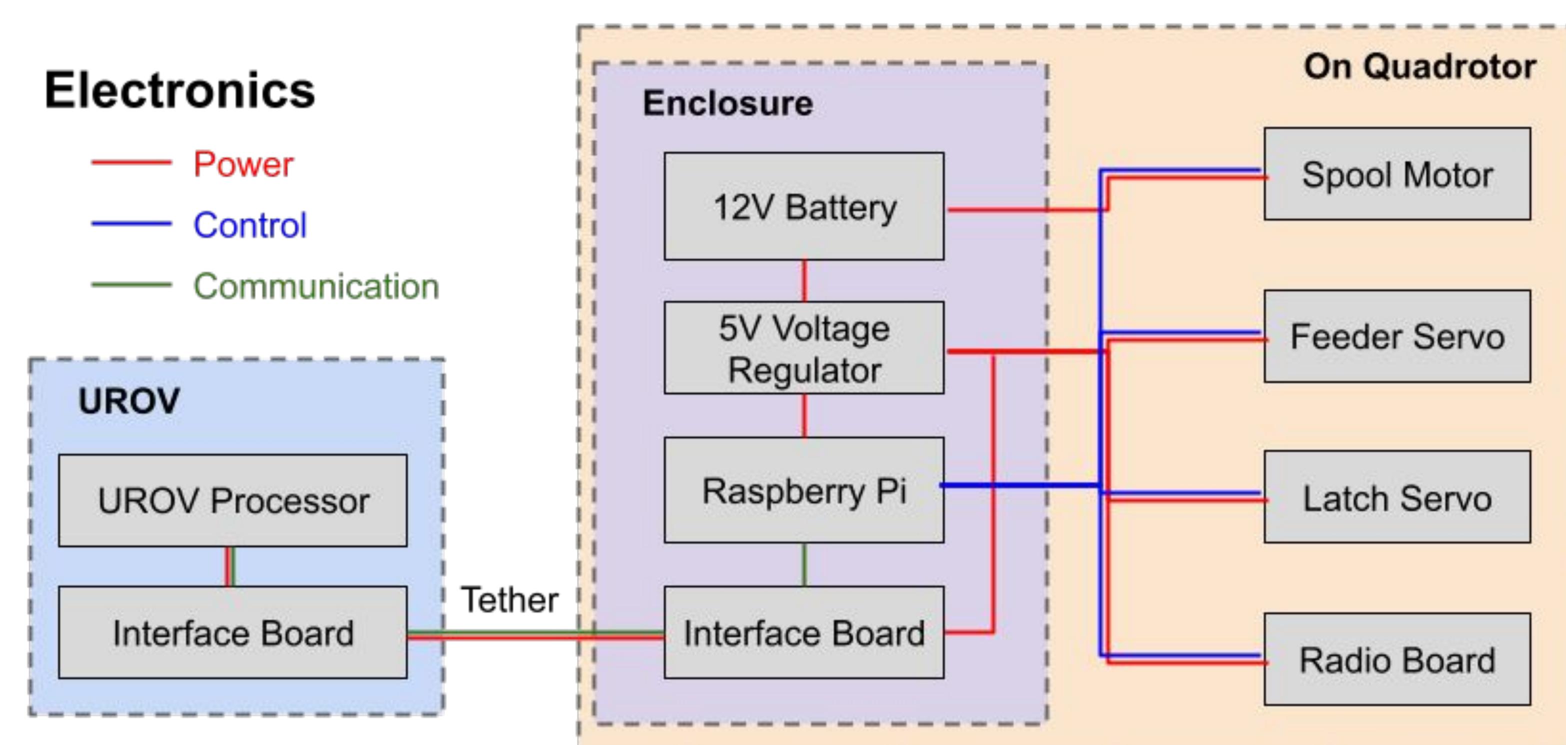
Given
- $m_{Bearings} = 0.0028$ kg
- $Impact_{Bearings} = 0.091$ Pt/kg
- $m_{Slider} = 0.026$ kg
- $Impact_{Slider} = 0.11$ Pt/kg



*Impacts calculated using the ReCiPe2016 endpoint

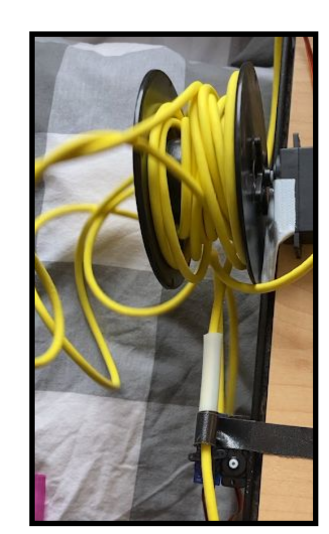
Final Design



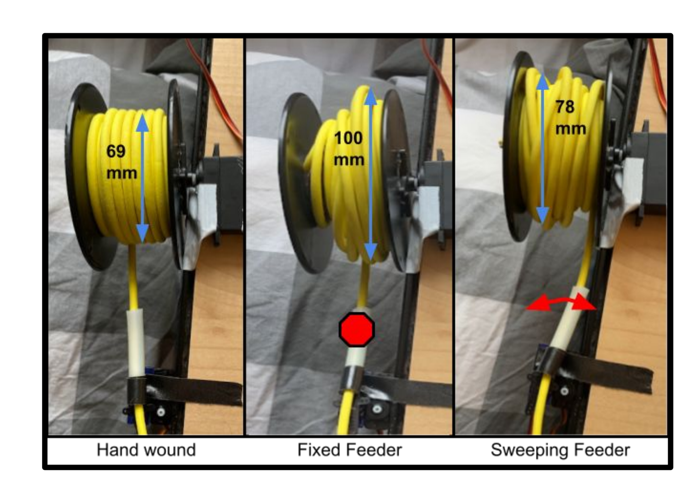


In our design, the UROV is connected using a tether that is wound by a feeder around a spool on top of the quadrotor. The UROV is secured in flight by a spring-loaded latch. The system communicates with the user by radio remote control, and is controlled by a Raspberry Pi that communicates with the UROV through the tether.

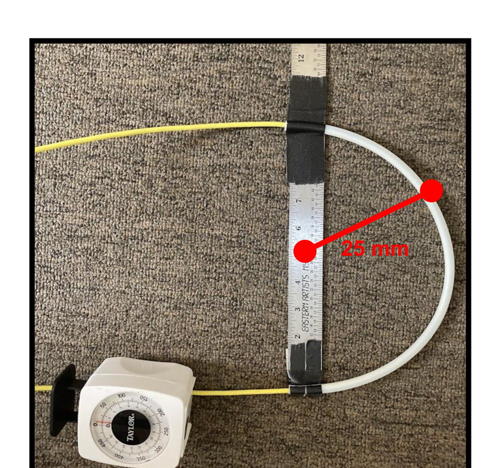
Prototype & Test Results



Goal
Determine tether spooling behavior.
Outcome
The tether will **tangle** when loose or exceeding the retaining wall of the spool.



Goal
Determine how evenly the tether will spool with different winding mechanisms
Outcome
Reeling in with a sweeping **feeder servo** results in a tightly wound spool within the walls of the spool, reducing the chance of tangling, compared to a fixed feeder.



Goal
The tether-routing bowden tube creates friction against the tether as it is pulled through.
Outcome
The force needed to pull the tether through is **0.33 N**.

Goal
Determine whether a similarly sized UROV can pull out the tether.
Outcome
The UROV **can** pull out the tether.