Problem Definition

Our group designed a low-cost lightweight underwater manipulator to grab, sample, and inspect various objects. It was designed for use with the BlueROV, but is largely compatible with other commercial submersibles.

Applications
- UMD researchers need their submersible to have a manipulator for research
- Sampling of oysters in commercial farming
- Companies can use submersibles to remotely inspect underwater
- Repair marine machinery while submerged

Major Goals
- Develop a cheap, replicable and lightweight arm
- Have a various degrees of maneuverability
- Create a remote operating system

Design Calculations & Analysis

Arm Motor Selection

\[ \Sigma M_x = 0 = (W_x)(L) - (W_y)(L + 0.1) - (W_z)(L + 0.1) \]

Torque Requirements
- Derived using FBD equations
- 100 kg-cm needed for shoulder joint.
- 40 kg-cm needed for elbow joint.

Shoulder and Elbow Motors
- Two 70 kg-cm servos for the shoulder joint
- Two 40 kg-cm servos for the elbow joint

Grip Strength

\[ F = \frac{W}{A - \frac{t}{2}} \]

5.5-7.5 lb max grip strength

Waterproof Test Results

- IP68 Waterproofing
  - 5 ft depth
  - 30 minutes
- 4” x 5” PVC testing apparatus
- Orange silica moisture indicating beads turn green when wet.

Parts Tested
- SLA resin parts
- SLA resin seals
- FDM PLA parts (100% infill)
- Static o-ring seals
- Dynamic o-ring seals

Prototype & Test Results

AquatiClaw - TEAM 20
“Team Name v37”
William Dickstein, Ethan Hays, Thomas Milne, Liam Roy, Tomas Silberberg, Odinn Waguespack

Final Design

Gripper
- Gripper can extend to pick up objects 1-4 inches in size.
- Claws are driven by a central threaded rod and stepper motor.
- Claws are easily interchangeable to accommodate various applications.
- 3D printed SLA and PAHT-CF

Wrist and Elbow
- Elbow and wrist joints combine with the shoulder subsystem to give 3 DOF.
- Allows user to inspect items in view of BlueROV camera
- Central tube for wire management
- 3D Printed in PLA and PAHT-CF

Shoulder
- Two shoulder base designs that mount to BlueROV payload skid.
- Two elbow mounting configurations.
- High torque servos for large lift capacity and precision control.
- 3D Printed PLA and PAHT-CF

Electronics Capsule
- IP66 4” PVC electronics housing
- Can be upgraded to IP68+ with BlueROV acrylic/aluminum enclosure.
- Attached to BlueROV skid with 3D printed PLA mount.

SLA Resin and O-Ring Seal Tests

Prototype & Full Assembly

Low Fidelity Prototype
- Remotely controlled using a commercially accessible Playstation 2 controller.
- Designed for ease of assembly.
- Limited mounting points allow for quick deployment.
- Modularity of various components ensure versatile application.
- Overall low cost with upgradable subassemblies to accommodate varying stakeholders

Medium Fidelity Prototype

High Fidelity Prototype

10 Weeks of Evolution of the Gripper Subsystem

Low Fidelity Prototype

Medium Fidelity Prototype

High Fidelity Prototype