Underwater Remotely Operated Vehicle (ROV)

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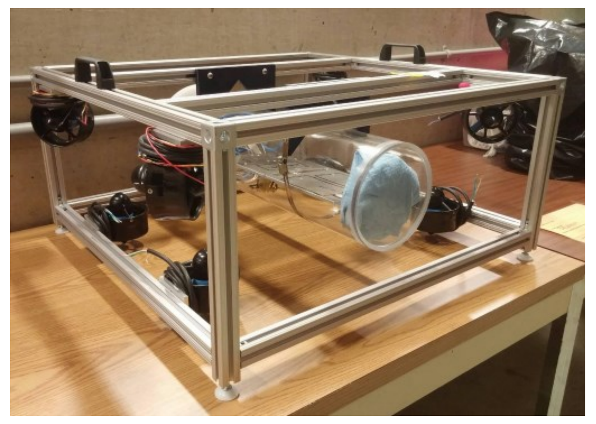
Design Considerations

- Lightweight, compact underwater unit with high computational capabilities
- Modular chassis design with focus on ease of transportation
- Additional degrees of freedom (DOF) for movement
- Optimal thrust and precision maneuverability without large power requirements
- Feedback control system capable of controlling depth and possibly orientation
- Further improvement to user interface through implementation of an Oculus Rift
- Slight positive buoyancy for recovery during system failure
- Valve system for easy attachment and removal of electronics tray endcap
- Center of mass and buoyancy adjustment system

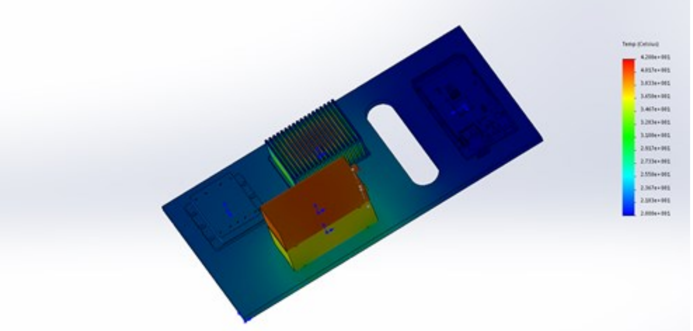
Chassis Design

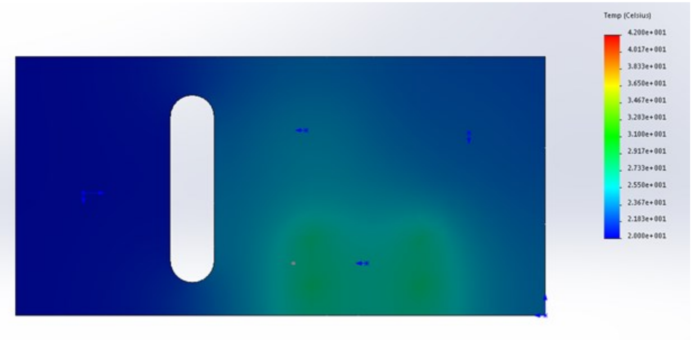
- Modular Aluminum 80/20 Frame
- Quick component repositioning
- Entire frame can be rescaled as need arises
- Slide fastener system allows fine trim adjustment
- 6015-T5 Aluminum: 200 MPa Yield Strength
- 8 Thrusters with 2.87 lbf thrust force each available
- Single tube watertight electronics enclosure



Heat Buildup Analysis

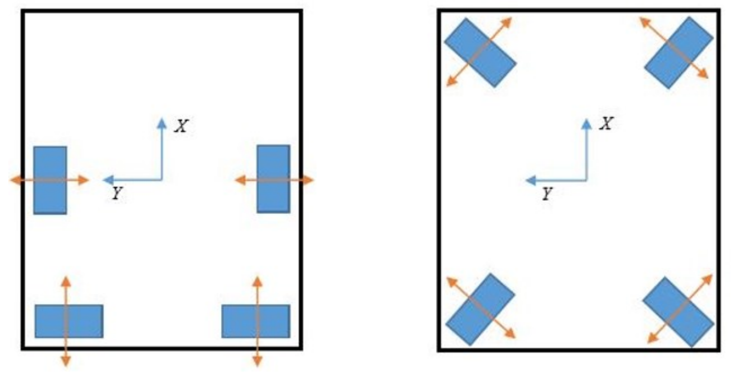
- Initial design showed potential of heat buildup within electronics tray
- Heat simulations performed with computational software
- USB Extenders found to generate most heat while system is under load
- Aluminum electronics tray design allows for large heat sink within the tray
- Ambient water temperature adds further cooling capabilities
- Simulated under worst-case scenario, presented with no heat issues

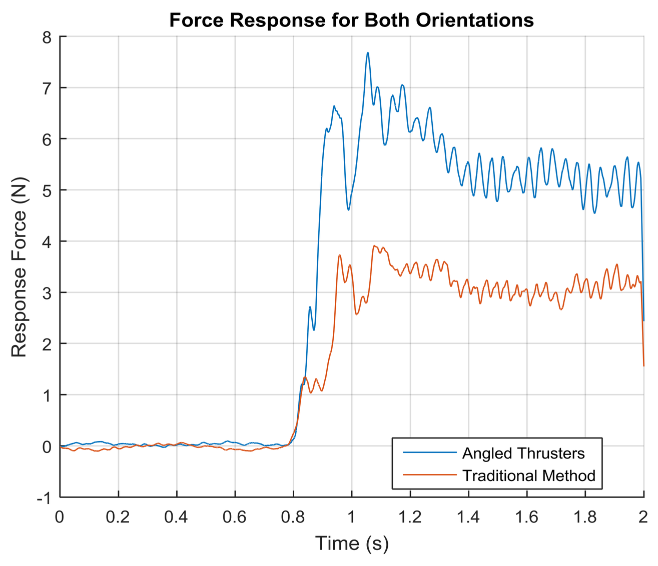




Propulsion Analysis and Design

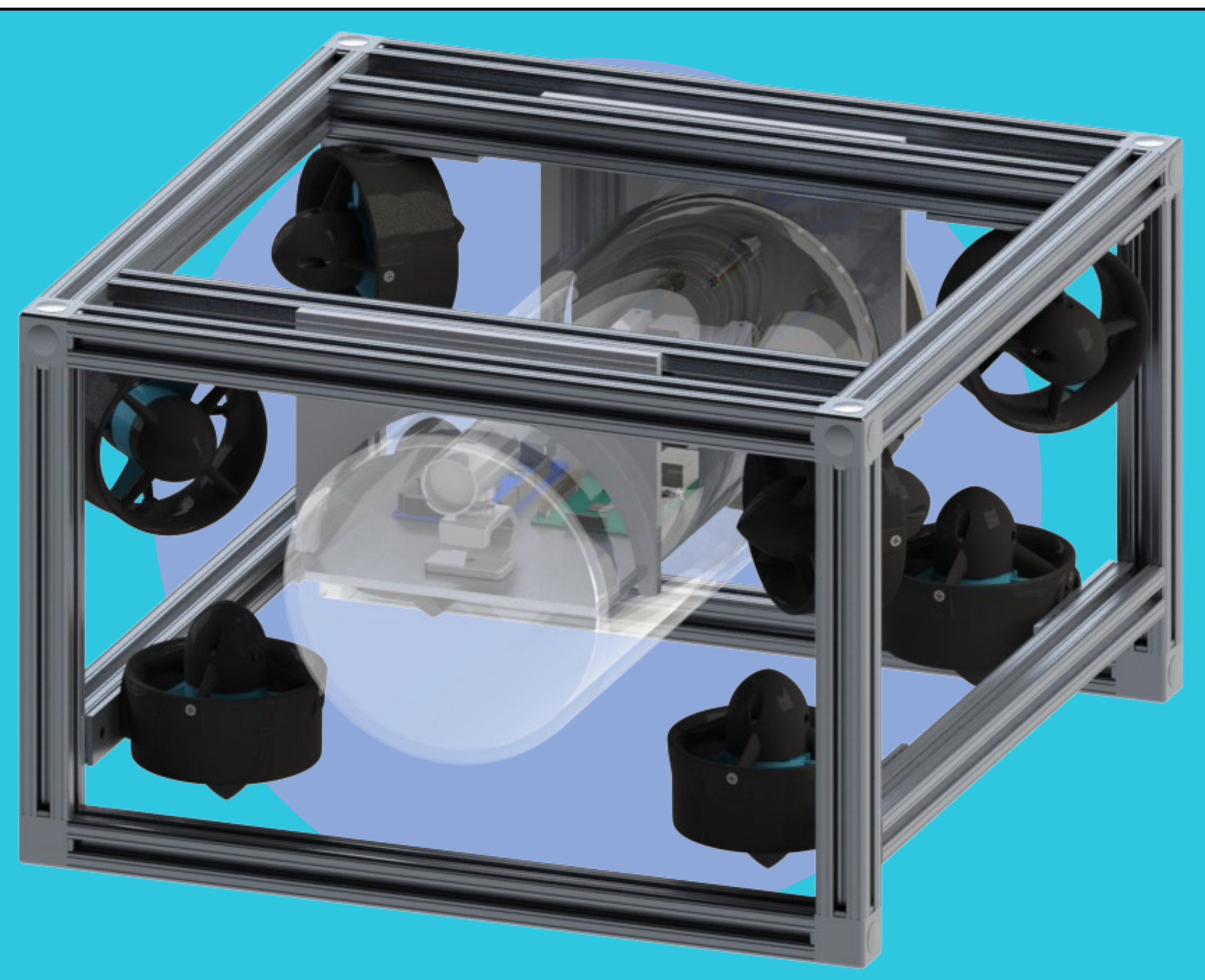
- Traditional vs. Angled Thruster orientation tested
- Simulation performed on both orientations
- Angled orientation found to provide $\sqrt{2}$x thrust
- Orientation also provides complex maneuvers
- Allows for high precision during operation





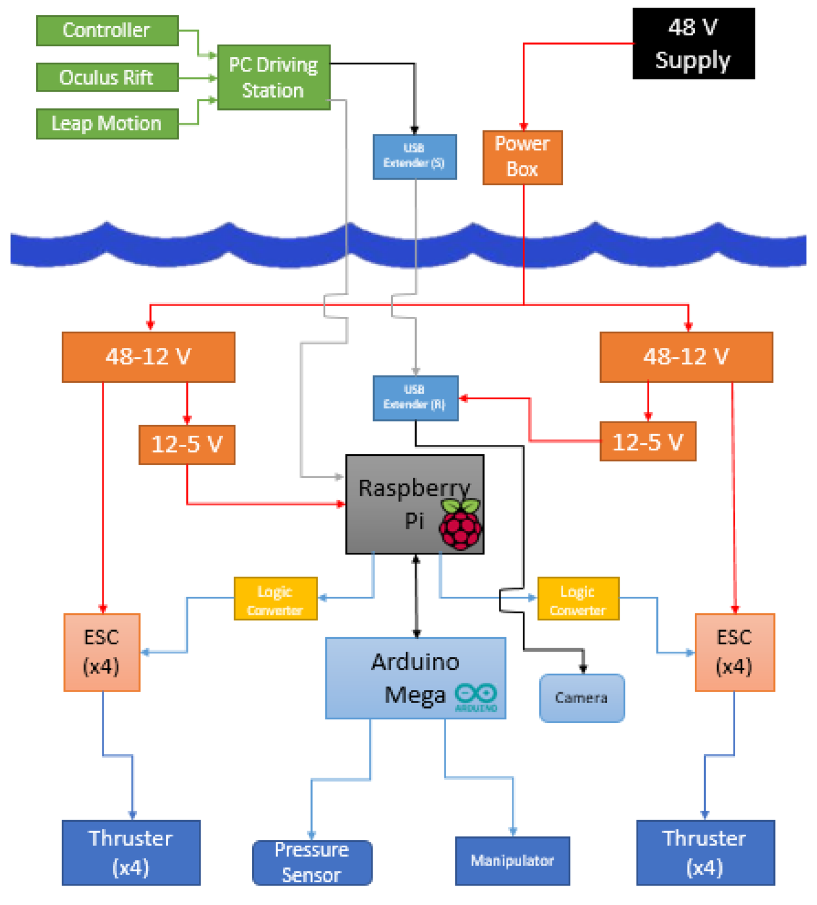
ABSTRACT

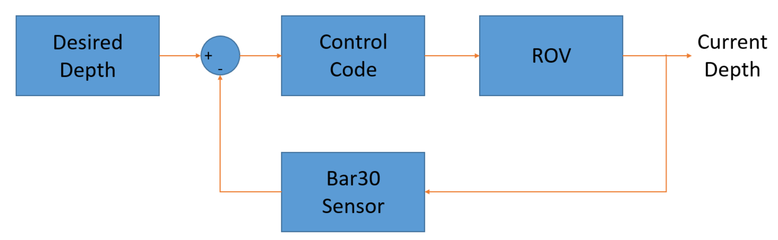
UNH ROV is an interdisciplinary engineering team dedicated towards the design and fabrication of an underwater remotely operated vehicle. This year's iteration of the ROV, known as Siren, was designed with constraints provided by the International MATE ROV Competition and research specifications, such as size, weight, power consumption, and system capabilities. Design models of Siren were conceived through computer-aided modeling and numerical simulations, and verified through prototyping and testing processes. Several innovations to legacy ROV designs include an overhauled propulsion system, further operator interactivity through virtual reality (VR) technology, faster onboard computer, and an optimized control platform. Ongoing tasks include implementation of feedback control and communication with an Autonomous Surface Vehicle (ASV). Through innovative ideas, analytical tools, and robust engineering design, Siren presents an advanced underwater ROV platform capable of many aspects of research, competition, and industrial application.



Electrical and Control Systems

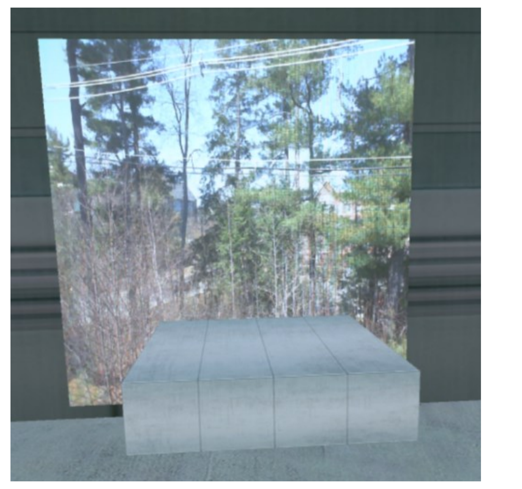
- Power supply provides primary power to all systems
- 48 V power stepped down to 12 V and 5 V, used by thrusters and microcontrollers, respectively
- Thrust modulation provided by Raspberry Pi, Arduino MEGA controls pressure sensor and manipulator
- Camera feed transferred through isolated USB extender to surface station
- All control programs executed through the Pi
- Drive code and data transfer modules initialized upon ROV startup
- Real-time communication between PC-Raspberry Pi–Arduino MEGA
- Sensor feedback directly to Pi and PC
- Feedback depth control code allows ROV to hold position at desired depth





User Interface and Virtual Reality

- Xbox 360 Controller serves as main user input device
- Buttons mapped to specific functions of ROV
- Camera feed transmitted to Oculus Rift Virtual Reality (VR) environment
- Oculus HUD to provide higher degree of accuracy and depth perception
- Leap Motion Controller integrated into VR environment
- Leap allows for precision control of mechanical armature
- SSH-based system allows for system diagnostics, system reboot, and other troubleshooting from surface



Armatures and Sensors

- Mechanical arm controlled from surface through Leap
- 2-DOF requirement: rotation and grip
- Motion of arm achieved through servos
- Servos not inherently waterproof, achieved through disassembly and reassembly in mineral oil
- Servos sealed with O-rings and Loctite for waterproof assurance
- Blue Robotics Bar30 Sensor allows for pressure, temperature, and depth measurement with high accuracy
- Depth measurement will be used for depth feedback control

Importance of ROV and Application

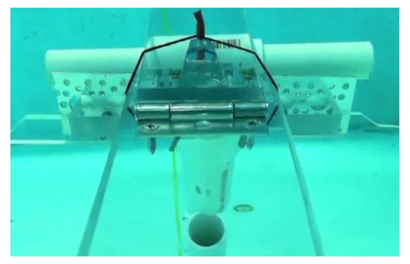
MATE Competition

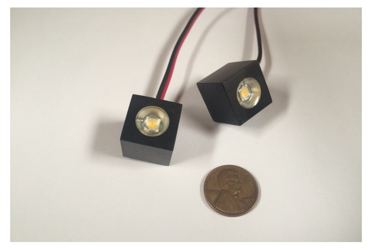
International ROV Competition, this year hosted at NASA Johnson Space Center Neutral Buoyancy Lab in Houston, TX

- Mission Tasks
  - Mission to Europa
  - Equipment Recovery
  - Forensic Fingerprinting
  - Deepwater Coral Study
  - Securing an oil wellhead

Research Applications

- ROV Leader-Follower System
  - Use a signal light and optical detection array to control a fleet of ROVs
- ROV—ASV Communication
  - Cross platform communication between ROV and ASV teams
  - Initial 'ping' tests for proof-of-concept
  - ROV flashes a light, ASV sees the flash and replays the flash above the surface





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