UNH Aquacats

University of New Hampshire, Durham, New Hampshire, USA

Team Members: Jarrett Linowes (CEO, ME '15), Nathanial Cordova (COO, ME '15), Sayward Allen (Treasurer, ME '15), Shaun Hespelein (Chassis Captain, ME '15), Gerald Rosati (Controls Captain, ECE '15), Sathya Muthukkumar (Controls Engineer, ME '15) Alex Dzengeleski (Chassis Engineer, ME '15), Jianqing Ye (Controls Engineer, ME '15), Zhuo Xu (Controls Engineer, ME '15), Alex Sarasin (Controls Engineer, ECE ' — Project Advisors: Professor May-Win Thein, Professor M. Robinson Swift; Graduate Advisor: Firat Eren

Company Information

The 2014/2015 UNH Aquacats team members

ABSTRACT

UNH Aquacats is an interdisciplinary engineering team focused on designing, fabricating, and testing an underwater Remotely Operated Vehicle (ROV). The design incorporates a high degree of modularity by accounting for constraints defined by the mission tasks presented by the international MATE ROV Competition as well as the inclusion of marketable designs for ease of use versatility. Each part of the design was conceived using 3D modeling software, analyzed using finite element simulation packages, and verified through a prototyping and testing process. By using cutting-edge methods in team dynamics, analytic tools, and engineering design, UNH ROV is able to maintain continued success in developing underwater robotic systems used for various different platforms for research and competition, geared toward various marine technologies.

Design Rationale

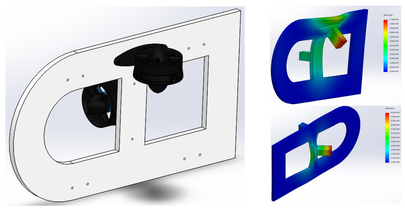
The designed ROV involves 3 separate and united systems: the chassis and tether system, the propulsion system, and the control and human interface system. The Aquacat's ROV was primarily designed with the following potential capabilities in mind:

- Underwater measurements of objects (including distances, width, and height)
- Precision manipulation of objects and the environment underwater
- Modular design allowing various uses as a platform for scientific applications
- Threat detection of ice bergs and other large objects
- Sea floor mapping capabilities

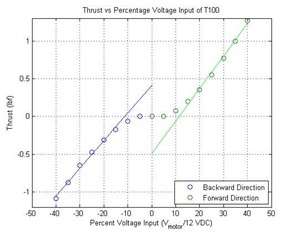
With a modular and open frame design in mind, the ROV can easily be modified for the necessary capability in mind.

http://soundwaves.usgs.gov/2007/05/MonaSW1LG.jpg

Propulsion and Chassis Design



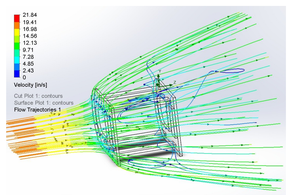
Simulated shear testing on the side panels



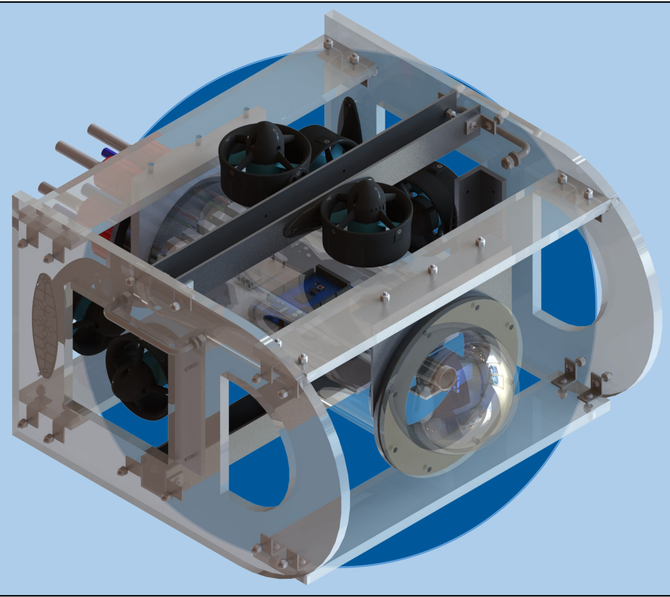
Forward/Backward comparison of thrust with percent maximum voltage

- 6 thruster configuration with 5 degrees of freedom — X, Y, Z, Yaw, Pitch
- Compared Seabotix BTD 150 (brushed) vs **Blue Robotics T100 (brushless)** thrusters
  - 5.2 pound-force, operating voltage of 12 Volt and maximum amperage of 11.5 Amps

The Frame was designed to be modular and open with fluid dynamics and buoyancy in mind. It is primarily assembled and machined using high density polycarbonate, aluminum, and acrylic for a high strength to weight ratio.

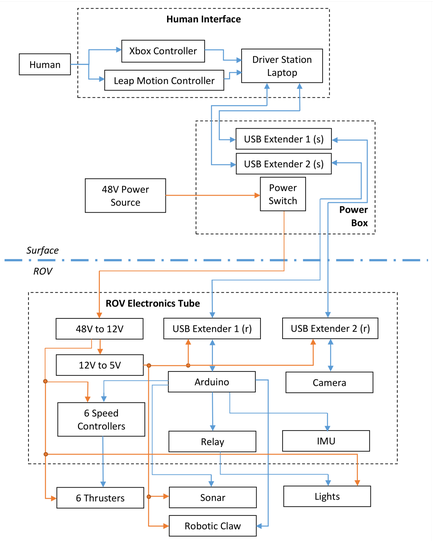


Fluid flow simulation for the frame design



Systems Diagram

- Power box that provides a "universal hub" for all power and data cable transfers
- 48 V power source stepped down to 12 V and 5 V
- Camera and video feed utilize isolated USB extender to ensure high bandwidth data transfer
- Internal/external forward/backward component communication between the surface, and ROV
- Speed controllers feature custom BlueRobotics firmware specifically written for brushless forward/reverse movement



Control and Human Interface

- Xbox 360 controller using the Xinput API as primary input device for drive control
- Leap Motion controller paired with Leap SDK for precision drive using reduced thrust and mechanical manipulator arm control
- Manipulator control by mapping digital representation of your hand to servos.

LEAP MOTION

http://froont.com/leaptomax/x43u13/_static-uploads/images/thumbnail/leap-

XBOX

http://pulp365.com/wp-content/uploads/2014/06/

Leap motion & Xbox 360 controllers provide the bulk of the human interaction with the ROV

The Xbox 360 controller includes a button for pitch control, allowing the driver to re-level the ROV using the two top thrusters.

- 6 DOF IMU for orientation feedback, stabilization, and leveling of the ROV
- Sonar sensor for underwater target measurement. Objects measured by a pixel-based system using distance and visual feedback

http://www.olimex.cl/images/MCI-SEN-01311_MCI-SEN-01311.jpg

Safety Features

The ROV includes many safety features for both the vehicle as well as humans and the environment. If there is a system failure, the ROV will drop its payload and surface due to being slightly positively buoyant. The electronics and tether have been tested as individual components, the system was then dry tested, and then finally tested in water with no exposed wiring. The propellers are enclosed in a hard plastic casing within the frame of the ROV.

Theme

- Arctic themed mission task demonstration
  - Oil pipeline repair and inspection, pipeline manipulation, and operation in an arctic environment
  - Underwater research, potroleum engineering and hamunitary relief organizations could all use ROV's to enhance their own industries and protect the Earth's oceans
- Capabilities in artic environments including
  - Initial site survey of terrain and soil types
  - Installation of marine renewable energy structures
  - Cabling of electrical and optical cables
  - Maintenance surveys of the final installation

Company Evaluation

- UNH Aquacats consistently overcame feats in which we initially felt would be unachievable
- Team dynamics included a controls team and a chassis team which often over lapped influencing our success with this years modular design.
- The incorporation of a ballast tank would allow the ROV to handle heavier loads
- Being an engineer on a project of this caliber and collectively building the product from the ground up has been the most rewarding part of this experience
- Establish a better power management system early on in the build

Special Thanks: Dr. Martin Renken, Tara Hicks Johnson, Scott Campbell, Kevin Maurer