Edison Submersibles

Purdue University
West Lafayette, Indiana, USA

"Pushing water, pushing boundaries"

Mission Summary

Task 1: Complete Primary Node and Install Secondary Node

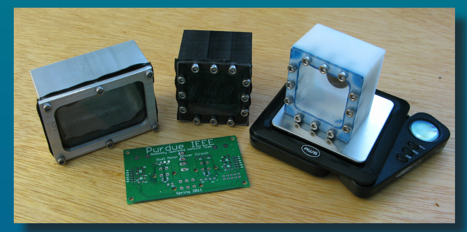
The Scientific Interface Assembly (SIA) is carried down in ROV *Model N*'s manipulator, and the pilot lowers it into position on the Backbone Interface Assembly (BIA). Using the hook on the top of the manipulator, the pilot may grab the Cable Termination Assembly (CTA) from the seafloor, hold it in an upright orientation with a hook on the top of the manipulator, and insert it into the bulkhead connector on the BIA. Once the secondary node is in the correct deployment site, the ROV will land on top of it such that each of the turning motors aligns with the four handles on the legs of the instrument. The pilot then moves ROV *Model N* to open the BIA door, retrieve the secondary node cable connector using the manipulator and attached hook, and insert it into the appropriate bulkhead connector.

Task 2: Construct and Install Transmissometer

ROV *Model N* takes the transmissometer down from the surface in the manipulator. The ROV rests the transmissometer on the simulated ocean vent using the guideposts to achieve alignment of the transmitter and receiver through the medium. Using a Vernier voltage probe, relative opacity is plotted against time on the company's custom GUI.

Task 3: Replace Acoustic Doppler Current Profiler (ADCP)

Power will be disconnected from the suspended mooring platform by using the manipulator to remove the platform connector from the bulkhead connector. The fast-acting pneumatic manipulator is next used to turn the handle in order to unlock the hatch before opening the hatch itself. The ROV removes the ADCP from its cradle and returns it to the surface. The mission crew exchanges the old ADCP for a new one. The ROV then returns to the mooring platform to install the new ADCP. The incredible power-to-weight ratio of the ROV allows a two-way trip to the surface in a short amount of time. The pilot uses the manipulator to close the hatch and relock it using the handle. By grabbing the platform connector using the hook on the manipulator, the connector may be re-inserted into the bulkhead connector with the proper orientation in short order.



Camera prototypes

Task 4: Remove Biofouling

During the completion of the other tasks, the ROV may return video showing biofouling on the seafloor equipment and instruments. The pilot may position the ROV directly in front of its forward thrusters and activate "tornado mode." This is a programmed vector thrust configuration that does not displace the ROV, but spins the forward motors quickly. The turbulence from the front thrusters will safely detach the biofouling organisms without requiring the pilot to release any object in the manipulator. Once all mission tasks are complete and all biofouling is removed from the equipment, the ROV may return to the surface.

Acknowledgements

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. . . and Purdue Student Government!

Discounts or Non-Monetary Donations

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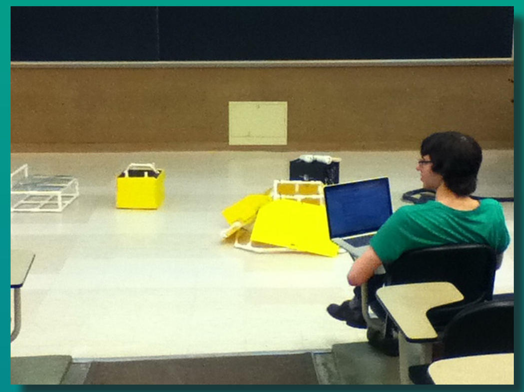


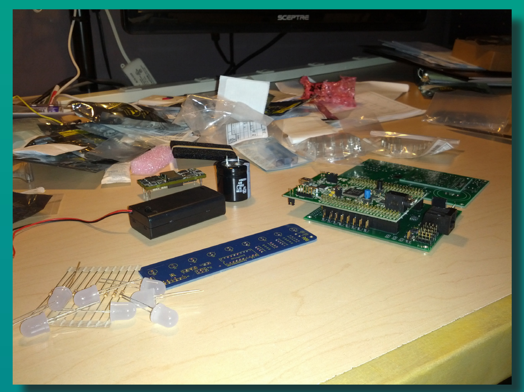
Modifying the ROV design to interface better with the mission props

The electronics box being machined

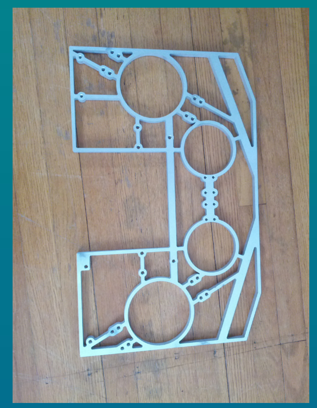
Abstract

Edison Submersibles, formerly Aperture Aquatics, designed and constructed ROV *Model N* to meet and exceed the requirements set forth by the 2013 MATE International ROV Competition. This includes installing the Scientific Interface Assembly and replacement Acoustic Doppler Current Profiler, leveling the secondary node, and deploying a transmissometer to measure ocean turbidity. At 68 cm long, 61 cm wide, and 47 cm tall, ROV *Model N* is capable of performing all these tasks with peerless speed and maneuverability.

Designed with reliability, stability, and speed in mind, ROV *Model N* is capable of maneuvering with six degrees of freedom. It has four thrusters for horizontal movement and four thrusters for vertical movement. The payload tools have been designed specifically for the mission and include a main gripper, turning motor leveling system, and spring-loaded measuring tool. All of the electronic hardware responsible for power management, vehicle movement, and sensor data collection, has been designed and fabricated from the ground up. The on-board and base station software was designed and developed by the company. ROV *Model N* is fully functional and capable of performing the tasks presented.



The apartment where much of the electrical work was done



One frame half immediately after machining

Team Safety

The Purdue IEEE ROV Team considered safety during both construction and operation of ROV *Model N*. Operation of all power tools required the use of OSHA approved glasses. The use of advanced tools owned by the team, such as a drill press and horizontal band saw, is safer than hand drills and hack saws when used properly because the work piece is not held by the user. In the team's five years of operation, only few minor scrapes and no substantial injuries have occurred.

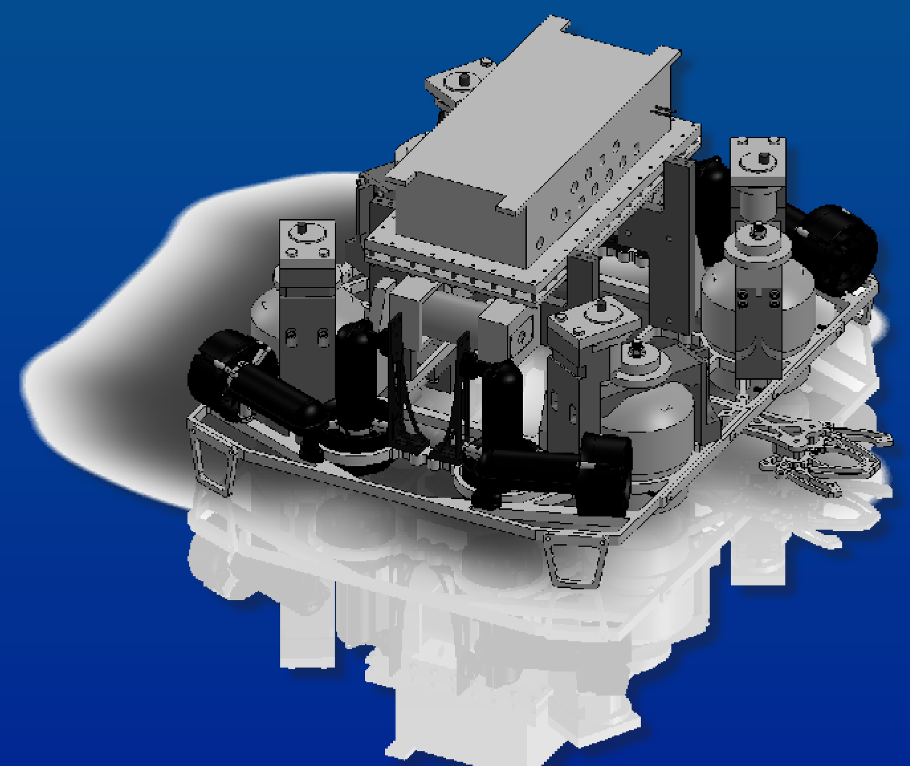
Design Rationale

Cameras
-3 cameras: front/manipulator, rear, and down/leveling
-Super Circuits brand wide-angle board cameras with the former two inside custom waterproof enclosures

Pneumatic System
-Surface compressor charges on-board accumulator
-Solenoid bank for distribution between tools
-Surface venting for increased pressure differential

Tether
-23 m long
-2 x 10 AWG wire, Ethernet, 2 x pneumatic tubes
-Foam core for neutral buoyancy

Transmissometer
-Powered by 12 Vdc from surface
-Output of phototransistor passed through lock-in amplifier and Vernier voltage probe to measure light attenuation



Thrusters
-8 x Seabotix SBT166 Thrusters
-28.4 N of thrust each at rated 50 Vdc
-20° inward offset on horizontal thrusters to allow sideways motion

Turning Motors
-Single docking to mate all four secondary node legs to the bilge pump motors
-Uses accelerometer to automatically level and manual input to fine tune

Shape & Frame
-Sturdy, lightweight aluminum frame cut by water jet and anodized
-Stainless steel bolts and nuts protected by anti-corrosion Tef-Gel lubricant and spaced away from frame by lacquered washers

Buoyancy & Ballast
-Electronics box provides positive buoyancy
-Vehicle made neutral and balanced using hydrostatic foam and stainless steel washers

Measuring Tool
-String with a tab wrapped around a 7.62-cm, spring-loaded spool
-Twelve-notch Gray code encoder measures length to 2-cm accuracy

Mission Statement

We meet challenges large and small with our full force and tenacity. In our continual quest for self-betterment, we design innovative and reliable tools that combat our obstacles. We learn from history but look to the future to realize our goals.

Mission Theme

With an ever-growing majority of the world's population spending their lives near the ocean, issues such as water pollution and sea level rise can become risks to the health and quality of life of the entire human race. With rising global temperatures, the ocean is absorbing more heat and experiences rising surface temperatures and higher sea levels. For example, one consequence of this phenomenon is the formation of stronger storms that have an undoubted cost in property damage and human lives. Because changes in the ocean take decades or longer to come into full effect, it has become a priority among oceanographers to monitor the oceans and to learn from the data they collect.

Diagram of a regional-scale node from the OOI project (courtesy of nature.com)

One novel solution to monitor the ocean is the formation of an ocean observing system (OOS). Real time data about the health of our oceans is obtained by combining underwater sensing equipment with information from buoys, satellites, coastal stations, and weather instruments. The Ocean Observatories Initiative (OOI) engages various institutions to develop the infrastructure to install and maintain the underwater equipment. These institutions are increasingly turning toward ROVs as the crucial link between equipment in a lab and the start and continued transmission of ocean data. The work Edison Submersibles has done on ROV *Model N* makes the dream of a widespread OOS one step closer to reality.

Information courtesy of:

1. http://www.epa.gov/climatechange/science/indicators/oceans/index.html
2. http://coseenow.net/about/ocean-observing-systems/
3. http://www.oceanobservatories.org/about/planning-history/

Company Evaluation

This is the fifth year for the Purdue IEEE ROV team. The team began in 2009 with four team members, a $500 budget, and a 5th place international finish. With the team size increasing to seven, nine, and seventeen and the budget increasing to $6,000, $14,700, and then $24,000 in 2012; the team rose in its final placement at the International Competition to 4th, 2nd, and 2nd just last year. Dedicated to earning 1st place this year, the Purdue IEEE ROV Team returns in force with fifteen members and a $25,000 budget.

The team experienced its first transition of the captaincy and coped with changes in experience, management styles, and communication methods. With many of the past stalwarts of the team graduated and moved away, the team wrestled with its own inexperience designing and constructing ROV's. However, with the strong legacy of the team and mentoring from those past team members, the team came to terms with its abilities and still produced a superb ROV. The team has learned more collectively this year than any other year since its inception. The process of seeing the vehicle come together from just a sketch on paper while learning long-term skills along the way is the most satisfying experience on the team. The team would like to address the challenges of this year by continually learning to use the design software to reach the assembly stage of the vehicle in less time. With a year of growth, the returning members of the team next year are setting their sights higher.

Company Information