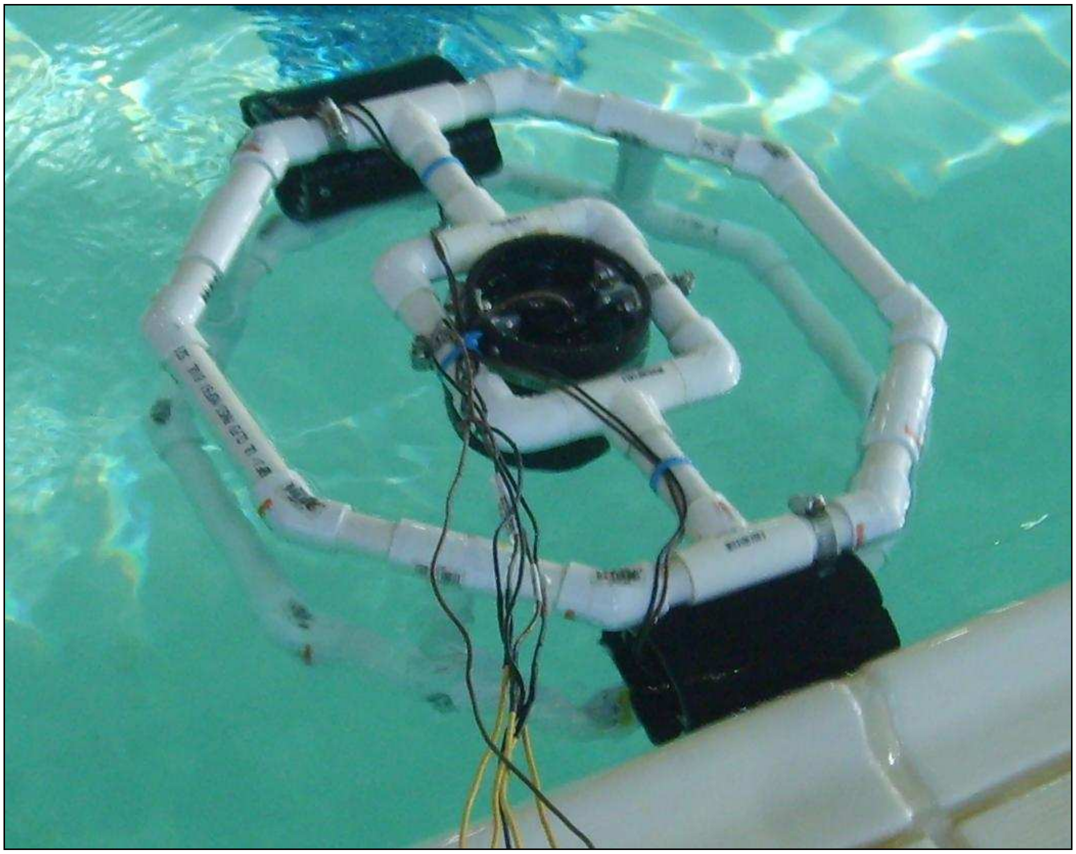

Clatsop Community College ROV Team's

Unidentified Floating Octagon

Joe Rorex, Team Member
Curtis McBride, Team Member
Jarrod Jackson, Team Member

Nicholas Stewart, Advisor
Pat Keefe, Advisor
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Abstract

Our goal was to build a Remotely Operated Vehicle (ROV) with an adjustable ballast system, variable speed motor drivers, and to have computer-controlled navigation. In order to accomplish our goals we constructed a hollow frame of Polyvinyl Chloride (PVC) that could be pressurized. We designed a computer navigation interface that utilized a data acquisition (DAQ) device, Pulse Width Modulation (PWM), and customized motor drivers. Ultimately, we built our ROV to accomplish the mission objectives.

Design Rationale

Our team spent a lot of time conceptualizing a ROV. In designing each aspect of our ROV we considered the mission objectives. A configuration that combined using the frame for ballast and electric motors with propellers for movement was the result.

Ballast System

The first versions followed a rectangular frame design that was rendered early in the year preceding the competition using Blender3D software (Figure 1). The major feature of this design was an adjustable ballast system.

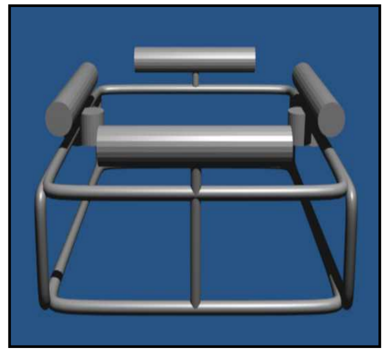


Figure 1. An early rendition of the ROV in Blender3D v2.43

This adjustable ballast allowed vertical movement of the ROV through pressurizing and depressurizing. The release of pressure from the ballast would allow water to enter the frame from small holes in the bottom, allowing the ROV to descend. The ROV can come to a point of equal buoyancy at any depth of the pool by the use of compressed air.

Frame Structure

With the plan to use the frame as the main ballast, we sought to make it from a light material that could be sealed. The team constructed a frame of 1.9cm Polyvinyl chloride (PVC).

Several shapes were considered initially, but an octagonal shape was the final result. A design that was large and cubic in shape was deemed too large and the ballast was unnecessarily large. The octagonal design itself was a modification of another concept of a 3d octagon that also had disadvantages.

Figure 2. The octagonal frame design.

The main supportive structure of the ROV consists of two octagonal rings of 1.9cm PVC with four connecting pieces between them. This shape is advantageous because it has a flat top and bottom. This feature allows any devices on the ROV to sit in close proximity to the pool surface or floor (Figure 2).

Robotic Arm & Collection Device

The team ended up with two separate devices. The majority of mission tasks will be carried out by an arm with an aluminum claw. The gripping power of the claw on the arm is provided by a spring-loaded pneumatic cylinder.

The shape and the dimensions of the claw are specific to the size of the objects it is intended to grip and carry. The length of the arm, and the distance from the ROV to the claw, will allow it to reach objects without interference from the ROV frame.

In anticipation of losing grip, a constant compressing force by the claw on the object is necessary. The team chose the spring-loaded pneumatic cylinder for this reason. Among many other advantages in favor of the pneumatic cylinder, was the absence of electricity and therefore of possible electrical failure.

A smaller netted device on one end of the ROV will capture the ping-pong balls from the surface in mission 2. This specialized device consists of two matching u-shaped pieces of metal with plastic netting.

One of these (net A) is fixed, projecting outward from the top of the ROV at 180 degrees to the ROV. Net A has excess netting to allow space for several ping pong balls.

The other (net B) varies a full 90 degrees from the point where net A is affixed and parallel to net A to a position perpendicular to net A and parallel to the ROV frame. This can allow our ROV to move slowly up to a ping-pong ball and secure it. Net B will function similarly to a lower jaw and close by turning on a motor to close it against the other

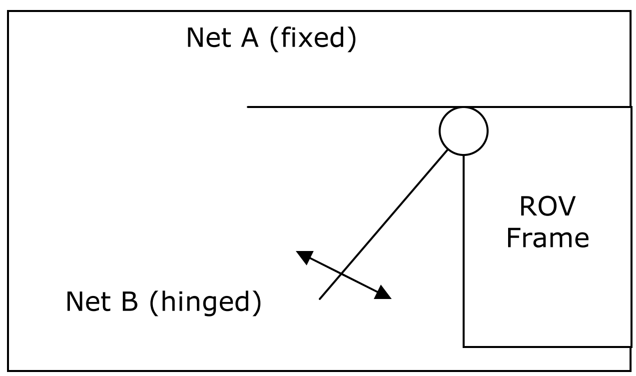


Figure 4. Conceptual drawing of nets.

Propulsion

To improve performance of the propulsion, we chose to enclose the motor and propeller in a tube of PVC. This theoretically provides a tunneling effect that improves the thrust by forcing the stray currents to move along the direction of the tube. More importantly, this also provides effective shielding from perpendicular current. The small aluminum brackets, fabricated by hand, attach the motors to the PVC using stainless steel machine screws. The brackets were made low profile to reduce friction.

For propulsion we selected waterproof bilge pump motors, manufactured by Johnson Pump. Further work was thus not necessary to waterproof the motors. The motors chosen were small, with a range of 1 to 3 amps.

The submersible bilge pump motors were removed from the original plastic housings and, after being examined for manufacturing defects, were fitted with propellers. Typical radio controlled boat propellers, found at hobby shops, were used. Our propellers measure 70mm from tip to tip and are made of nylon.

Motor Control

Our design includes the use of computer controlled motor drivers. Software will be used, Labview 8.0, to interface with and control the I/O controller device. This I/O controller device is used to send a signal to the motor drivers. The motor drivers act as amplifiers and send the signal from the I/O controller device to the motors in the required voltage and current.

We will keep a simple toggle-switch controller handy in case of difficulty with the computer controlled system.

Surveillance

We will be using cameras with built-in LED lighting. In addition to four cameras there will be two light sources to provide illumination at each end of the ROV.

Materials

PVC tubing is our material of choice for frame construction, mainly due to availability and ease of construction. PVC is a light and durable well suited for our application.

Aluminum and stainless steel were used wherever possible for lightness and to prevent corrosion.

Tether

The tether contains our electrical wires, air hoses, and video cables. The design requires a rather long tether that easily can interfere with navigation. To prevent this foam will be incorporated into the tether.

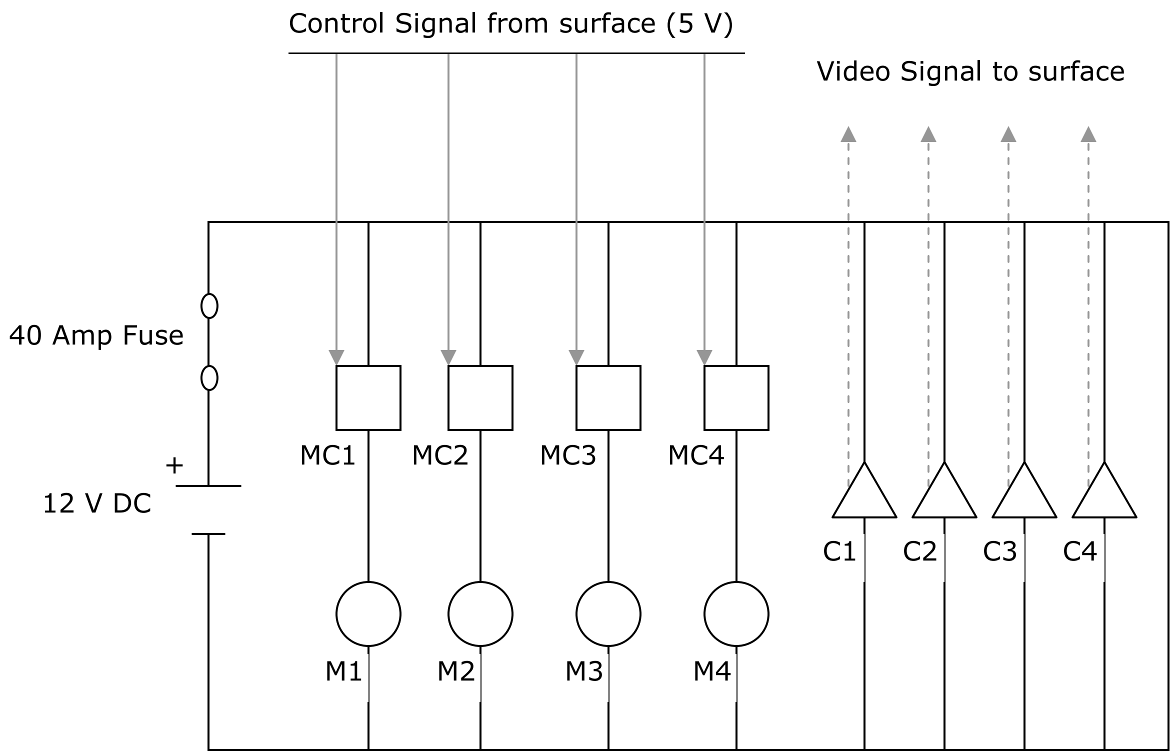
Electrical Schematic

The ROV is controlled by the navigator at a computer console. Using software written in Labview 8.0, the navigator sends signals to the motor drivers that control the current to the motors.

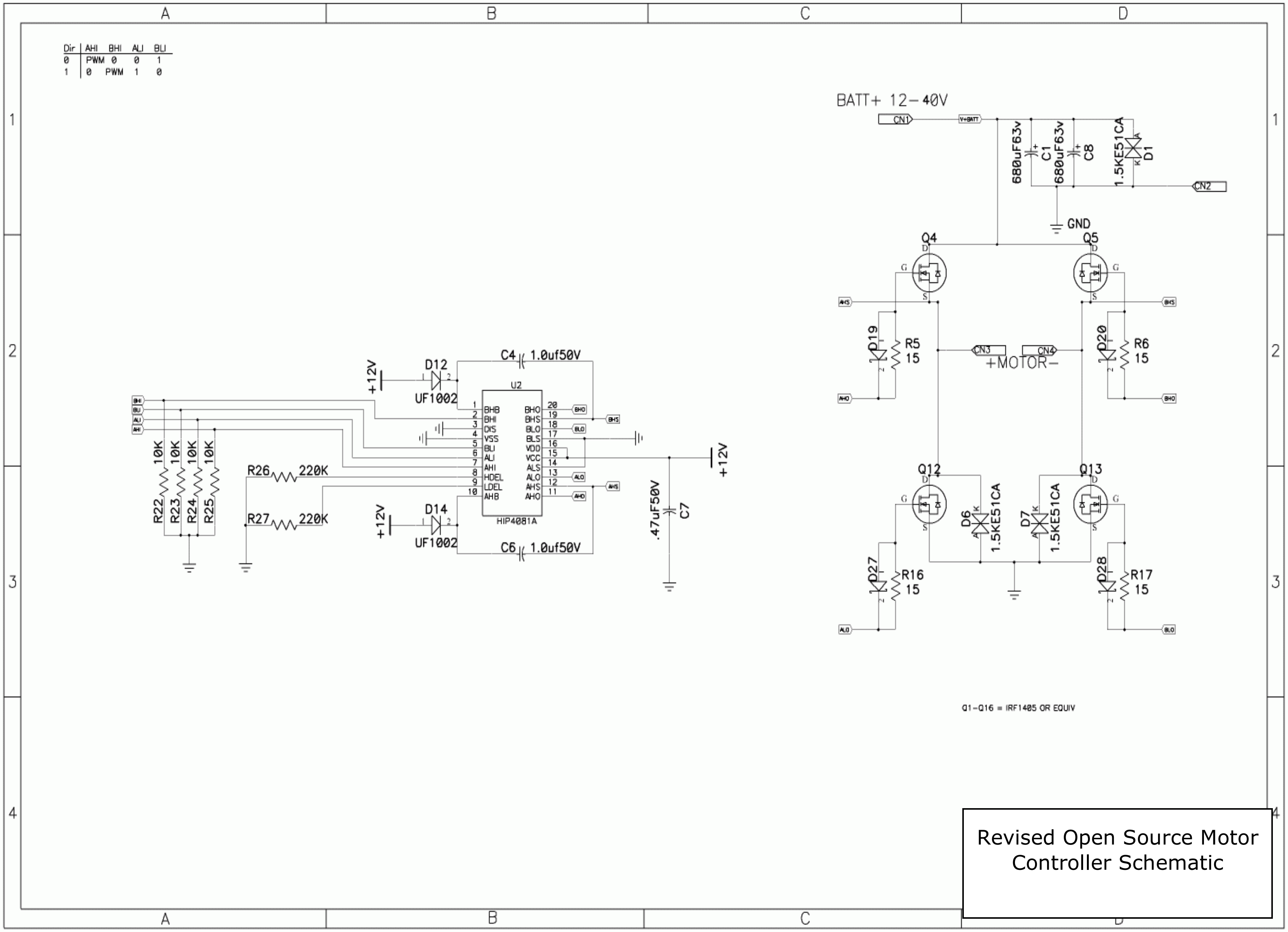
The cameras are wired separately from motors, and contain internal lighting.

Components: Power, cameras, PC with Labview 8.0 software to control the iUSBDAQ, USBDAQ I/O controller, motor drivers, motors, backup switching.

ROV Electrical Schematic

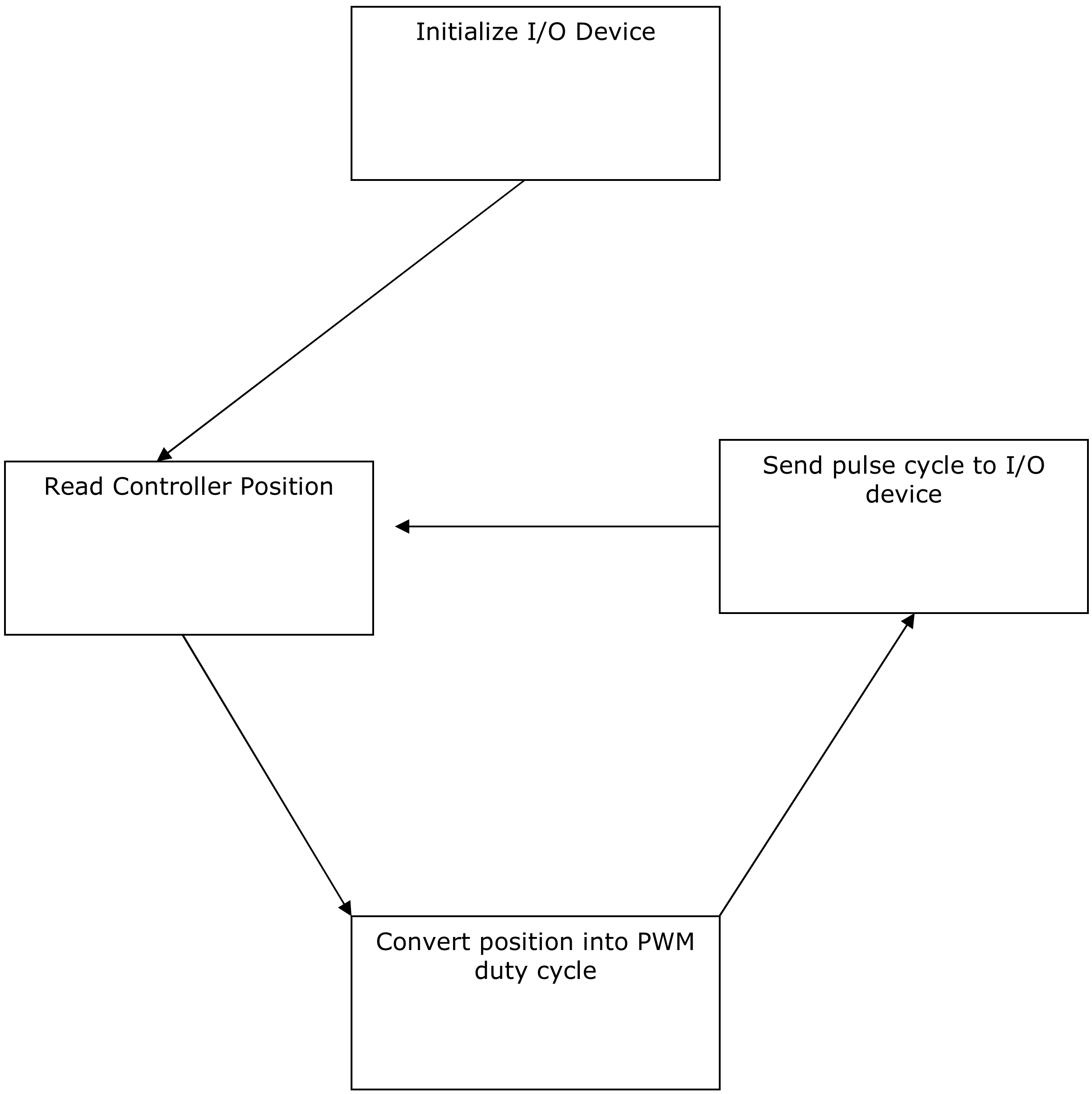


M = Motor
MC = Motor Controller
C = Camera



Revised Open Source Motor Controller Schematic

Software Motor Control Flow Chart



Challenges

What Time?

As college students we can often feel pressed for time, especially around midterms and finals. Two of the team members are involved in other extracurricular activities, including involvement in clubs, student government and the honor society.

In light of time constraints, time management was very important. This has proved very challenging with only three team members.

Making Decisions

Our biggest challenge in this project was coming to consensus on design. Finding agreement in the selection of the more arbitrary aspects of the ROV design was difficult.

Another important lesson here for us was about teamwork. One element to an effective team is to have everyone working together on different parts of a project.

Troubleshooting Technical Issues

Motor Switching

Early in the development of the design of a simple control system for electrically switching our motors we encountered problems running all four simultaneously. Initially, the motors we had appeared to work only momentarily or with delay. The team was unsure about the cause.

The team theorized that this was due to having too great of a load on the power source. It was soon discovered that one switch remained functional regardless of the operation of others. The wiring setup was double-checked to make sure there were no short circuits. Next, we reconnected the switches to each motor individually to test functionality of the motors. The motors indeed worked, and this proved that we had faulty switches. We then made the easy decision and purchased a new set of toggle switches.

Buoyancy

Another challenge that we encountered was working the kinks out of the adjustable ballast system. We discovered early in our testing that the ballast system seemed much more sensitive than we had anticipated. Through a process of elimination and with adjustments to the ballast system the problems were worked out.

Skills Gained/Lessons Learned

3D Computer Modeling

When the team first started discussing potential designs, one of the first barriers encountered was determining a medium for efficient communication. We made extensive use of notebook paper, dry-erase marker boards, and various props in the early stages. Eventually, we needed to get some of our ideas into a more manageable medium that was relatively easy to use and understand.

What we settled on was an open source 3D modeling program called Blender. We selected this software not due to ease of use or the steep learning curve, but because it was open source. Learning to utilize 3D modeling software to communicate complex design ideas was an effective way for us to succeed as a team, and it provided a valuable foundation of skills for the future.

Digital Circuit Design

When we went about the task of purchasing variable-speed motor controllers for the ROV, we discovered that these units tend to be quite expensive. In light of this, we began exploring alternative means by which to acquire said motor controllers. It was during this exploration that we came across the Open Source Motor Controller (OSMC).

The OSMC is another of the (now infamous to us) open source projects. Essentially, this project provided specifications to build our own motor controller which was capable of receiving a Pulse Width Modulation (PWM) signal and transmitting a regulated voltage to the motors. The OSMC forced us to analyze the electrical circuitry and components used when constructing electrical devices. With a basic understanding of how these circuits worked, we were able to modify the OSMC design to suit our needs.

Future Improvements

One drawback of the video system is the possibility of losing a camera due to a small leak. Two cameras at each position would be ideal. Additionally, a better interface for the cameras would aid in navigating the ROV. A new interface should at minimum allow for quick switching between the cameras and have a split screen view.

The propulsion system uses motors that do not provide equal thrust in both directions. For this reason, another set of thrusters in the opposite direction yet wired in the reverse would suffice. This could add a capability for redundancy, in the case of a lost motor, if they could be switched off separately.

The use of one metal for all components which were required to be rigid would be ideal. Over time metals will degrade each other through electrolytic reactions. Rather than put steel against aluminum, in the future we would seek to use only aluminum

Still further, if it were possible, all components would be plastics except for the necessary conductive materials. Real field applications of this at great depths may prevent challenges to this as plastics generally compress more easily than metals.

Budget & Finance Details

Revenues

With generous support from the Clatsop Community College Foundation, for example, we had more than enough to create the ROV. However, travel to St. John's, Newfoundland, Canada is costly. Although the cost of flying has been covered, at this time we still need to find money for the hotel stay and food.

Date	Sponsor	Amount
3/1/2007	Jensen Communications	$500.00
1/10/2007	Rochester Trust Fund	$250.00
1/1/2007	Physical Science Department	$150.00
3/5/2007	Lum's Auto Center	$25.00
4/10/2007	Clatsop Community College Foundation	$1350.00
1/1/2007	3rd Place Winnings from 2006 ROV Competition	$200.00
N/A	MATE	$1000.00
	Total (USD)	$3475.00
	Total (CAN)	$3724.85

Expenditures, page 1 of 2

Date	Item	Supplier	Qty	Cost/item	Total
1/18/2007	3/4" to 1/2" adapter	Astoria Builders Supply	2	0.89	1.78
1/18/2007	3/4" PVC pipe	Astoria Builders Supply	25	0.32	7.91
1/18/2007	1" PVC pipe	Astoria Builders Supply	10	0.69	6.90
1/18/2007	2" PVC pipe	Astoria Builders Supply	10	1.49	14.90
2/3/2007	3" PVC pipe	Astoria Builders Supply	6	1.69	10.14
1/18/2007	3/4" PVC Tee	Astoria Builders Supply	8	0.38	3.04
1/18/2007	3/4" PVC elbow 45º	Astoria Builders Supply	16	0.79	12.64
1/18/2007	3/4" PVC elbow 90º	Astoria Builders Supply	12	0.38	4.56
2/3/2007	3" ABS pipe	Astoria Builders Supply	4	1.85	7.38
1/18/2007	4" ABS pipe	Astoria Builders Supply	4	2.83	11.33
1/18/2007	3" ABS cap	Astoria Builders Supply	2	7.49	14.98
1/18/2007	2" PVC elbow 90º	Astoria Builders Supply	4	2.19	8.76
2/1/2007	2" to 1" PVC Reducing-Tee	Astoria Builders Supply	2	2.29	4.58
2/3/2007	2" PVC Tee	Astoria Builders Supply	2	2.69	5.38
2/3/2007	2" to 3" ABS adapter	Astoria Builders Supply	1	6.49	6.49
2/3/2007	2" PVC elbow 45º	Astoria Builders Supply	1	2.59	2.59
2/17/2007	Johnson Pump #16004	Englund Marine	2	33.57	67.14
2/17/2007	Johnson Pump #32903	Englund Marine	2	20.40	40.80
2/19/2007	4" PVC cap	Astoria Builders Supply	1	1.69	1.69
2/3/2007	*SS bolt 8/32*1"*	Englund Marine	4	0.07	0.28
2/3/2007	*SS bolt 8/32*1 3/4"*	Englund Marine	6	0.07	0.42
2/3/2007	Chain 3/8", Zinc	Englund Marine	2	1.19	2.38
2/3/2007	Cement (40 lb Bag)	Englund Marine	1	8.99	8.99
1/20/2007	1/2" barb Tee	Astoria Builders Supply	1	1.59	1.59
4/15/2007	Aluminum Bar 2"*1/4"*2'	Englund Marine	1	12.59	12.59
3/23/2007	Helping Hands (tool)	Radioshack	1	12.99	12.99
3/3/2007	1/2 A Fuses	Radioshack	2	2.59	5.18
2/19/2007	3/8"*3' all thread	Englund Marine	1	1.50	1.50
2/19/2007	*SS 334 U-Bolt	Englund Marine	1	2.65	2.65
2/19/2007	*SS 3/8" coupling nut	Englund Marine	2	0.25	0.50
2/19/2007	*SS 310 U-Bolt	Englund Marine	2	2.07	4.14
2/17/2007	Rule 1000 12v Pump	Englund Marine	1	21.36	21.36
3/3/2007	*SS Mics. Nuts & Bolts	Astoria Builders Supply	2	0.09	0.18
1/29/2007	RTV Silicone	O'Reilly Auto Parts	1	3.99	3.99
2/17/2007	2" PVC coupling	Astoria Builders Supply	1	0.79	0.79
3/3/2007	*SS clamp 3 1/8"-5"	Englund Marine	4	1.02	4.08
3/3/2007	*SS clamp 3/4"-1 3/4"	Englund Marine	16	0.66	10.56
3/3/2007	*SS clamp 4 1/8"-7"	Englund Marine	4	1.23	4.92
3/3/2007	*SS locknut, 8/32"	Englund Marine	7	0.06	0.42
3/3/2007	*SS screw #8*3/4"	Englund Marine	7	0.07	0.49

*SS-Stainless Steel

**At exchange rate: 1USD = 1.08CAN

Project Expense Total	
US $	3519.28
**CAN $	3800.82

Expenditures, page 2 of 2

Date	Item	Supplier	Qty	Cost/item	Total
1/20/2007	Oil pan	NAPA Auto Parts	2	4.19	8.38
2/8/2007	7"50LB, Black MH 100/pack	Englund Marine	1	2.05	2.05
2/26/2007	Lithium Batteries #CR2032	Astoria Electronics	6	4.19	25.14
2/11/2007	Pinnacle Systems Linx Editor	Amazon. COM	1	14.99	14.99
3/5/2007	Fine Emery Cloth	Astoria Builders Supply	2	1.89	3.78
3/5/2007	120 Grit Sandpaper	Astoria Builders Supply	1	0.69	0.69
3/5/2007	80 Grit Sandpaper	Astoria Builders Supply	1	0.83	0.83
3/1/2007	Halogen Light Bulb 20w 120v	Astoria Builders Supply	4	8.49	33.96
3/9/2007	Underwater Mini Cameras	Pine Computer	2	119.99	239.98
3/15/2007	Orange Ping Pong Ball	Links Outdoor	1	0.99	0.99
3/15/2007	Original O-balls (Rhino Toys)	KB-Toys	1	3.99	3.99
3/3/2007	fold-out display board	Fred-Meyers	1	4.99	4.99
1/20/2007	Mics. drain gasket	Astoria Builders Supply	1	1.99	1.99
1/20/2007	#6 .5" Self-tapping screws	Astoria Builders Supply	2	0.14	0.28
1/20/2007	1/8" polypropylene rope	Astoria Builders Supply	20	0.19	3.80
5/17/2007	Airfare	Air Canada	4	628.96	2515.84
			Total	(USD)	3186.29

Funds (USD)	3475.00
Expenditures (USD)	3186.29
Remainder To Date	288.71

**At exchange rate: 1USD = 1.08CAN

Project Total	
US $	3186.29
**CAN $	3441.19

Life in the Polar Regions

Living at the Poles

The Arctic Ocean has a large variety of animal, plant and human life. Currently there is an estimated human population of four million people that live north of the Artic Circle. Life at the poles is severe due to its unforgiving climate, and its isolation from the rest of the world. The people that call this place home have adapted to the extreme cold, snow- and icebound environment where the vegetation is almost nonexistent, trees are scarce, and caribou, seal, walrus, whale meat, and fish are the staple of their diet. Eskimos traditionally hunted seals with harpoons from kayaks, or they hunted on the ice shelves of the Arctic Ocean. Due to global warming the ice shelves that once provided a bountiful hunting ground for the Eskimo people have subsequently melted.

The three fastest warming regions on the planet during the last 20 years have been Alaska, Siberia and parts of the Antarctic Peninsula. The Polar Regions are remote areas of the Earth that have profound significance for the Earth's climate, and ecosystems. We remain oblivious to the real effects of polar climate changes. The scientists of the International Polar Year are performing research at the poles, to determine the cause and effects of global warming. Some of the current objectives of IPY are to explore new scientific frontiers, deepen our understanding of polar processes and their global linkages, increase our ability to detect changes, and to attract and develop the next generation of polar scientists, engineers and logistics experts. The overwhelming evidence of polar climate change motivated several international organizations to provide a study of the Arctic climate, the Arctic Climate Impact Assessment (ACIA). The Arctic Council, an intergovernmental forum with eight Arctic country members and six Indigenous Peoples organizations, and the International Arctic Science Committee (IASC) representing 18 national academies of science, released its report entitled “Impacts of a Warming Arctic” in November 2004.

Dogsleds were the main means of transport on land for the Eskimo people. Eskimo clothing was comprised of caribou furs, which allowed them to stay warm in the extreme cold. In the summer many Eskimos lived in animal-skin tents, and used animal-skinned kayaks to hunt seals. In the winter many Eskimos lived in igloos, and hunted on the seals from the ice shelves. Their basic social unit was the nuclear family, and the typical religion was animistic.

Due to the extreme conditions in the Antarctica and its isolation from the rest of the world, an indigenous human population has never existed there.

Fun Fact: Polar Bears and Penguins are never found living in the same environment, only at the zoo or on television can you see them together—Polar Bears are from the Arctic and Penguins are from the Antarctic.

Acknowledgements

Nicholas Stewart, for his consistent assistance in all things related to this project.

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Englund Marine, for offering us all of their products at a special discount rate.

Appendix

Sources

IPY-International Polar Year

http://classic.ipy.org/

IPY-International Polar Year (U.S. sponsored)

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