Submersible Remotely Operated Vehicle

2008 Clatsop Community College ROV Team

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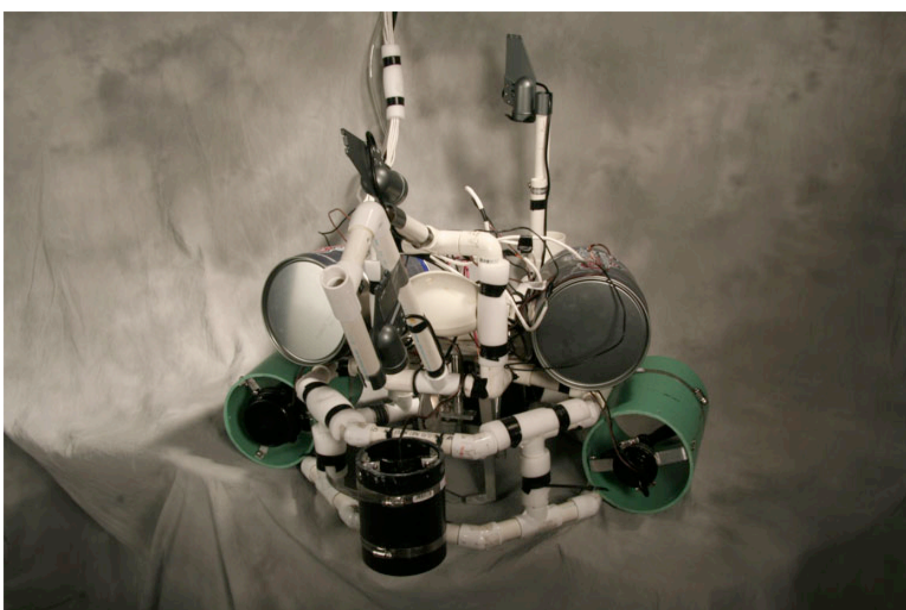

Sideburns 558

ABSTRACT

The preliminary phase of our project was to build a submersible ROV that could ascend, descend, turn left, turn right and go back and forth the length of the tether. Once this was accomplished we modified the ROV to complete the three tasks that we must accomplish in the 2008 MATE ROV Competition. They are to collect lava samples, to measure the temperature of an under water vent, and to free the ocean bottom seismometer. To do this we used five Johnson 4732 lph bilge pump motors for propulsion and maneuvering, three underwater cameras, a K type thermocouple for measuring vent water discharge temperature, and a pneumatic claw and ballast system for lifting the seismometer and sampling the lava. The 15 meter tether will carry 12 volt power for the motors from four double pole double throw switches along with three air lines to control the claw and lifting ballast systems. Three combined feed and power lines will also be run through the tether to supply the cameras.

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Figure 1 - Sideburns 558 Remote Operated Vehicle

FINANCIAL DATA

Funds

Date	Source	Amount
06/26/03	Gut & Glory Gift Card 2007	$100.00
12/09/04	Jenson Communication	500.00
01/31/04	Rochester Trust Fund	927.76
04/24/04	Columbia Pacific Maritime LLC	300.00
05/04/04	Physical Science Dept	414.43
05/16/04	MATE Travel Assistance	500.00
	Total Funding	$2,742.19

Donations

Date	Item	Supplier
05/02/03	Ballast Tanks	Paul Lenz
12/09/04	Cat 5 Network Cable	CCC Computer Services

Expenditures

Date	Item	Supplier	Qty	Price	Total
10/15/07	Thermometer	Safeway	1	15.99	$15.99
10/26/07	Color Mini Camera	Kermitinc	7	49.99	349.93
03/13/08	4732 lph Bilge Pump	Englund Marine *	6	29.01	174.06
03/14/08	Bidirectional DC Motor Controller	Carl's Electronics	4	22.46	89.84
01/25/08	12 Volt 7Ah Battery	Battery Mart	4	16.95	67.80
01/25/08	12 Volt Battery Charger	Battery Mart	1	16.95	16.95
02/25/08	Windshield Wiper Motor	Englund Marine *	1	101.37	101.37
04/20/08	Silicone Caulk	Astoria Builders Supply	1	4.99	4.99
04/25/08	ABS 10.16cm Pipe	Astoria Builders Supply	2	3.007	6.01
04/25/08	PVC 19.05mm Pipe	Astoria Builders Supply	3	0.477	1.43
04/25/08	Marine Clamp	Astoria Builders Supply	5	3.19	15.95
04/25/08	PVC 19.05mm Tee	Astoria Builders Supply	4	0.33	1.32
04/23/08	Mini-Giant Relay	4Compuelectron	18	1.89	34.02
				Subtotal	$879.67

Expenditures Continued:

Date	Item	Supplier	Qty	Price	Total
04/29/08	Relay Modules: 4-Pack	Bass Home Electronics	1	$24.28	$24.28
05/06/08	Caulking Gun	Englund Marine *	1	6.05	6.05
05/06/08	Gilnet Float	Englund Marine *	4	1.95	7.80
05/08/08	TV Solder	Astoria Builders Supply	1	0.69	0.69
05/08/08	Rosin Solder	Astoria Builders Supply	1	2.39	2.39
05/08/08	Ties cable	Astoria Builders Supply	1	18.99	18.99
05/08/08	Heat Shrink Tubing	Astoria Builders Supply	1	2.39	2.39
05/08/08	Nuts and Bolts	Astoria Builders Supply	6	0.55	3.30
05/09/08	Clear Silicone	Englund Marine *	2	6.25	12.50
05/09/08	Line Spool Box	Englund Marine *	1	13.05	13.05
05/16/08	Airfare & Car Rental	Orbitz	1	1401.06	1,401.06
05/16/08	Good Nite Inn	Orbitz	1	312	312.00
05/21/08	4732 lph Bilge Pump	Englund Marine *	1	29.01	29.01
05/21/08	4732 lph Bilge Pump	Englund Marine *	1	29.01	29.01
				Subtotal	$1,862.52
				Subtotal (from previous page)	879.67
				Total Expenditures	$2742.19

Funds	$2742.19
Expenditures	$2742.19
Balance	$0.00

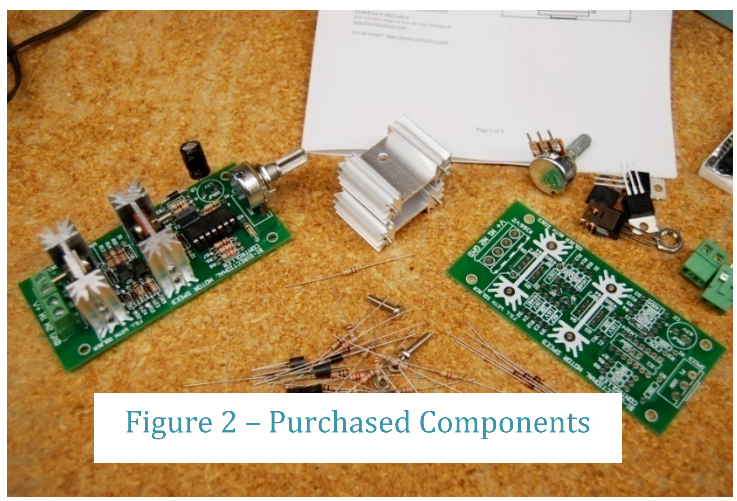

Figure 2 – Purchased Components

ELECTRICAL SCHEMATIC

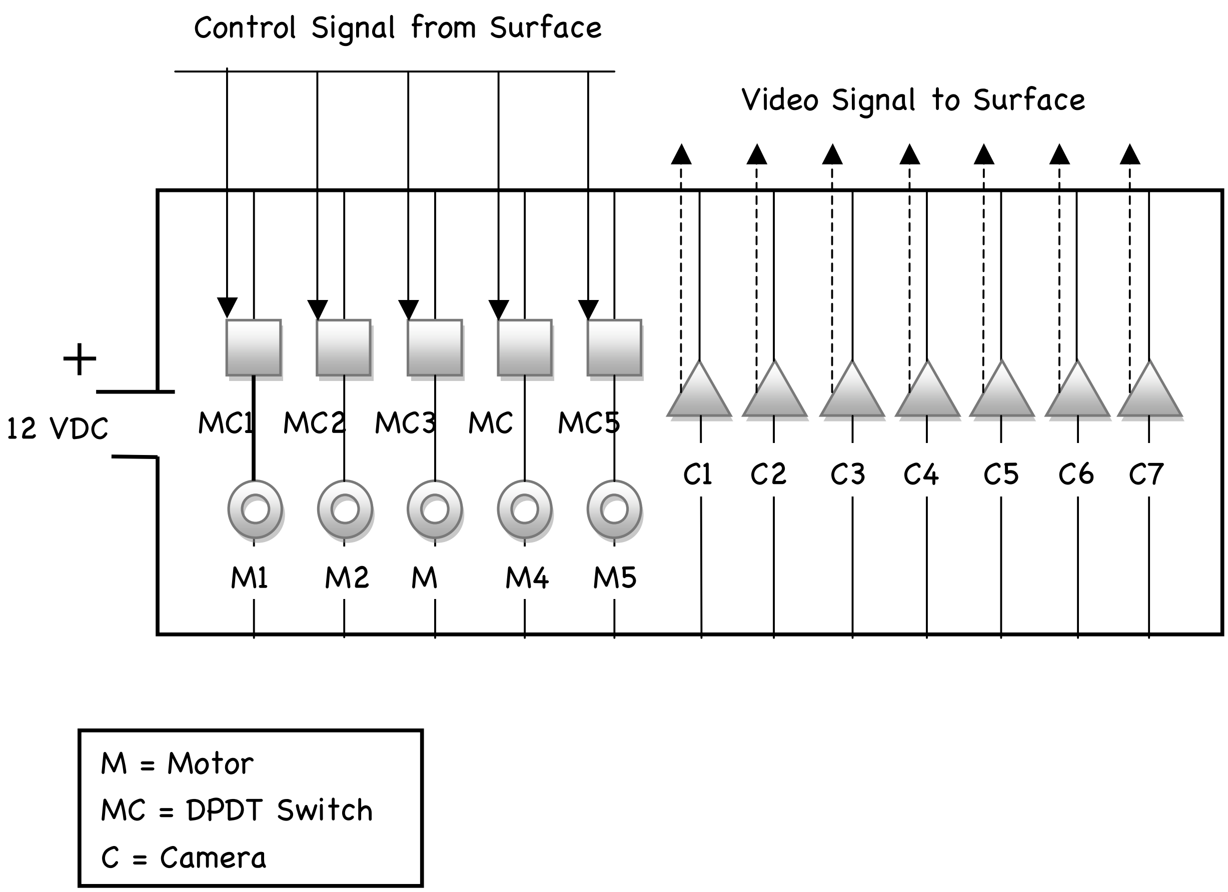

Figure 3 – Electrical Schematic

VEHICLE SCHEMATIC

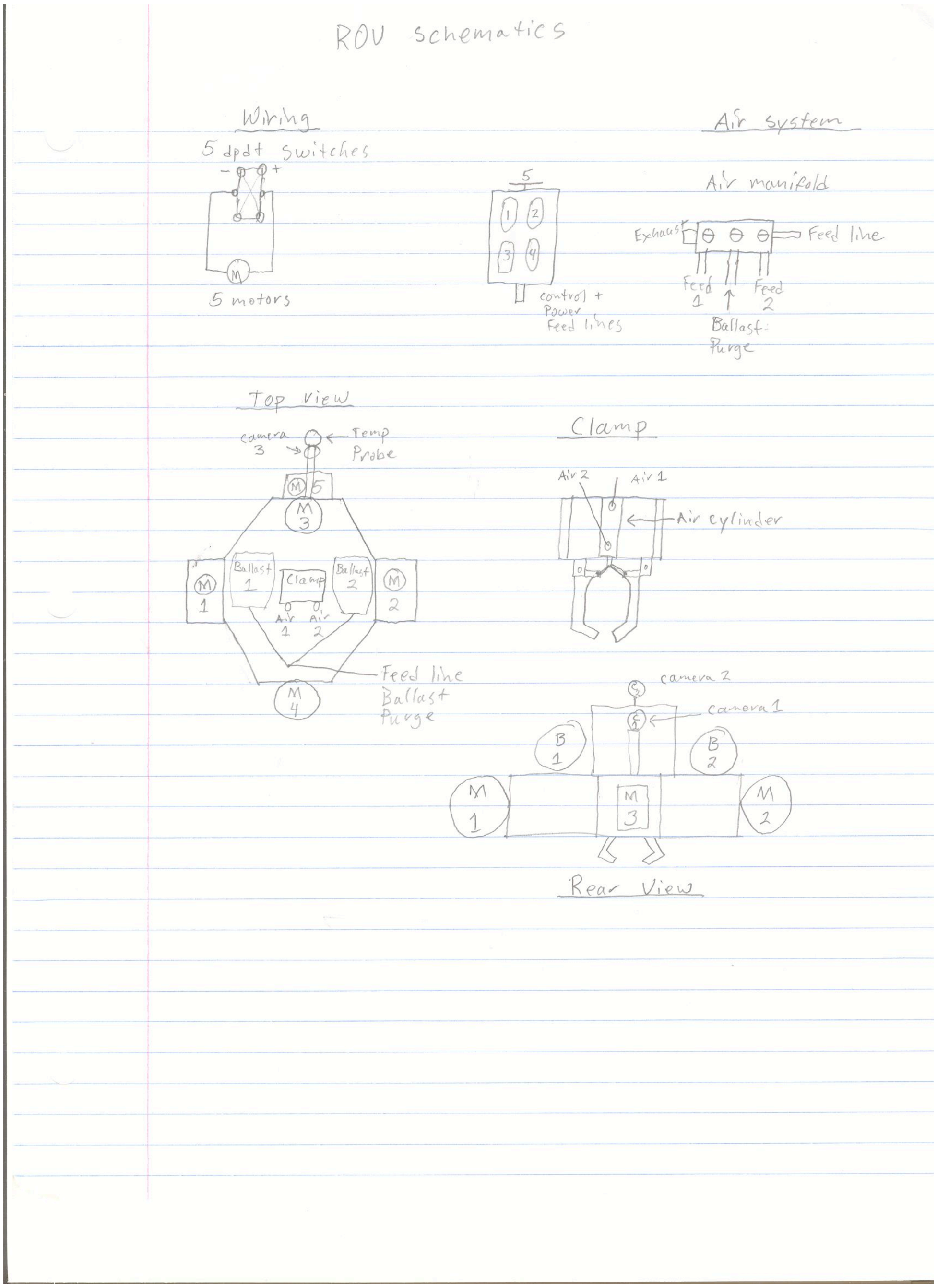

Figure 4 – Vehicle Schematic

HARDWARE ONLY CONTROL SYSTEMS

We decided on hardware only control to eliminate overly complex design requirements for the mission tasks assigned. Using double pole double throw switches and hard wired sensors and cameras also eliminated potential errors in software design and implementation.

DESIGN RATIONALE

Our team spent considerable time conceptualizing the Sideburns 558 ROV. Meeting the mission's objectives was the most important factor in each aspect of our ROV design. We developed a design configuration that combined using the vehicle frame for ballast and controllable electric motor driven propellers for ROV underwater movement.

Each propeller is hooked to its own engine. Potentiometers are hooked up to the engines so that the props have the ability to move in the forward and reverse directions. The bidirectional potentiometers also allow us to control how much voltage goes to a particular propeller. This ability will come in handy while turning left and right.

All of the propeller tubes and PVC joints are fastened together with either quick ties or screws. At the final stages of our project, we applied a Styrofoam sealant to the PVC joints to prevent water from getting into the pipes and throwing off the ROV's center of balance. It is important for our ROV to remain neutrally buoyant during our mission so that we have complete and accurate control over our propellers.

Ballast System

A major feature of our design is an adjustable ballast system. The adjustable ballast system allows for all vertical movement of the ROV by using the vehicle frame as ballast tanks. By using compressed air and pressurizing or depressurizing the frame of ROV, the operator

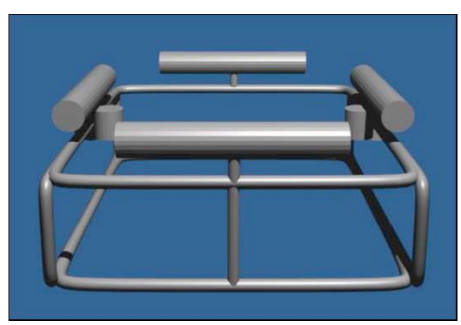

Figure 5 - An early rendition

can cause the ROV to rise, maintain, or descend. Increasing pressure causes the ROV to rise by forcing any water in the frame through small holes drilled into the bottom of the frame. Decreasing pressure to the system will allow water to enter the frame through the small holes causing the ROV to descend. By adjusting pressure to the ballast system, the ROV can come to a point of equal buoyancy at any depth of the pool.

Frame Structure

We constructed the frame of our ROV out of PVC pipes and joints. The PVC pipe was very inexpensive and easy to work with. Our team started out with a long piece of 1.9cm Polyvinyl chloride (PVC) pipe and cut it down into smaller pipes that were the same length.

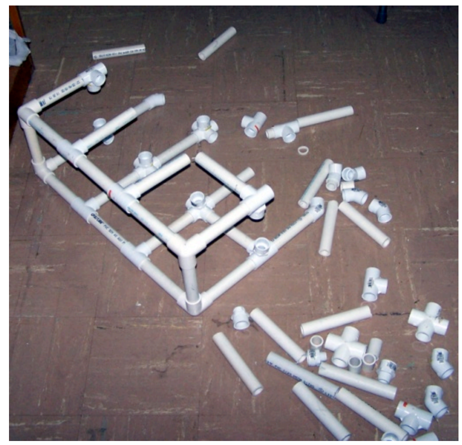

Figure 6 – Frame Component Assembly

Since the plan uses the frame as the main ballast, we sought to make it from a light, sealable material. Several shapes were considered initially, but we chose a boat-like tapered front so our ROV could propel easily through the water.

All of the propeller tubes and PVC joints are fastened together with either quick ties or screws. At the final stages of our project, we applied a Styrofoam sealant to the PVC joints to prevent water from getting into the pipes and throwing off the ROV's center of balance. It is important for our ROV to remain neutrally buoyant during our mission so that we have complete and accurate control over our propellers.

Propulsion

The group decided we would use two kinds of propellers; up and down propellers and left to right propellers. Each propeller is mounted inside its own PVC pipe tube so water is channeled more efficiently to each propeller, resulting in better propulsion. The PVC pipe enclosing the propellers also protects other critical components of the ROV (wires,

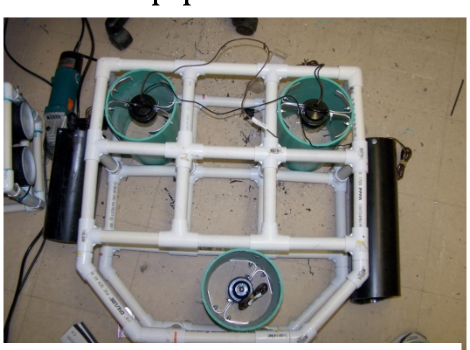

Figure 7 – Propeller Tube

framework, etc.) from damage. Three propeller tubes are mounted inside the frame of the ROV (two in the back and one in the front), and one propeller tube is attached horizontally on each side of the ROV.
Our group reasoned that three, six-inch propellers for the upward and downward motion would be beneficial for both the descent and ascent of the ROV. Two smaller, four-inch propellers are attached for the right and left motion since we believe turning in the water would require less force than the up and down motion.

Each propeller is attached to its own engine. Potentiometers are hooked up to the engines so the propellers have the ability to move in both forward and reverse directions. The bidirectional potentiometers also allow us to control how much voltage goes to a particular propeller motor resulting in power control. This ability will come in handy while turning left and right.

OVERCOMING CHALLENGES

While constructing the PVC pipe frame, our team discovered that some of the PVC joints had the wrong angle configuration to complete the tapered section of our ROV. Since the angles we needed were not pre-made, we had to customize the joints to fit our design. There are too many angle configurations for manufacturers to construct, so it is not surprising that we ran into this problem.

Other problems are money- it is tight to come up with, and personalities – the team needs to learn to work together in a group and have a common vision.

TROUBLESHOOTING TECHNIQUES

When it comes to solving technical problems, every team member's opinion is always considered. The more contributors and the more options, the better the possibilities are for solving the problem. The two best examples of this team brainstorming at work have to be our cameras and our buoyancy system. Each time we faced these challenges, we met to discuss possible solutions. In the case of the cameras, these included buying new ones, sealing them differently, and housing the cameras differently.

While testing the temperature measurement subsystem we found that the original thermometer attached to a boom could not be reliably read by the camera. To solve this problem we researched other methods of measuring temperature such as infrared and wireless temperature probes. We finally decided that a hard wired K type thermocouple feeding through a cat 5 cable to a multi-meter on the surface would be the most accurate and reliable system.

RESEARCH PROJECT- NeMO

The **Ne**w **M**illennium **O**bservatory

The Nemo Project, started in 1998, was designed to be a long-term study of how geological, chemical and biological elements interact along mid ocean ridge formations. The site chosen to conduct this project was the Axial volcano located about 400 km off the coast of Oregon on the Juan de Fuca Ridge. This site was chosen because of its high volcanic active and numerous hydrothermal vents that provide insights into events occurring deep within the earths crust. Also of scientific interest are the microorganisms that thrive in these inhospitable environments. Scientists hope that increased research into these microbes may help develop enzymes and design chemical reactions to produce quicker, more accurate and efficient commercial products and scientific experiment results.

Figure 8 – JASON ROV

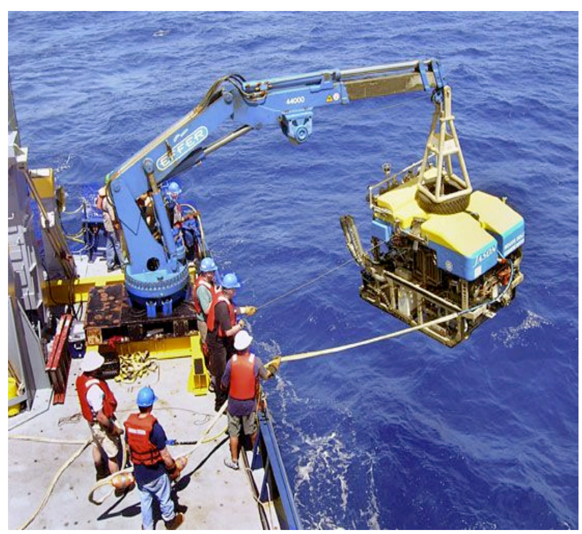
Figure 9 – Launching JASON

A project of this size requires quite a bit of effort and manpower. Up to 59 crewmembers and scientists are for up to 60 days on the 83m scientific vessel Atlantis. Numerous measuring devices are used to collect data including

CTD's (Conductivity, Temperature and Depth Recorder) devices, Vent Fluid Samplers (used to collect chemical content information from vents), and numerous underwater sonar mapping vehicles ranging from temperature to the height of the plumes emitted from the hydrothermal vents. However, not only are fully automated devices used, but ROV's are also used to set up the measuring devices, collect samples, and to give scientists the ability to explore the ocean floor from the safety of the mother ship. The main ROV used for this particular project is a 2000 kg submersible named *Jason.* Armed with three video cameras, a still camera and seven high-powered underwater lights, this ROV is capable of providing scientists with an up close and personal view of the ocean floor as deep as 6000 meters.

References

Remotely Operated Vehicle Jason - http://coastaltraining.org/page.do?pid=8423

NeMO: About NeMO - http://www.pmel.noaa.gov/vents/nemo/technology.html

NeMO: A Seafloor Observatory of Undersea Volcano Monitoring http://gcmd.nasa.gov/records/GCMD_NEMO_PMEL.html

Interview with Pat Keefe