R.B.M.A

Riviera Beach Maritime Academy

ROV: The Gaffer

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<u>Acknowledgements</u>

We would like to give thanks to:

Lockheed Martin ~ looked over are project and made sure things were going smoothly.
Riviera Beach Maritime Academy ~ Provided us with a facility to make our ROV and teachers to help us make it.
MATE ~ set up the rules and are holding the competition. Also supplied us with a travel allowance.
Florida Regional's ~ Thank you for allowing us to compete

<u>The following put on a presentation regarding ROV:</u>
Palm Beach County Fire Rescue
US Customs
Border Patrol

<u>Teachers</u>
David Sellepack
George Bradbury

Abstract

This year's ROV design was completely redone, using no components or even rough design from last years ROV. The biggest issue with last year was not being waterproof and weak motors. To fix these issues instead of using a PVC tube with end caps sealed with PVC cement and Teflon tape, we used a pre-manufactured dry box to house the electronics rated for 60 foot. This allowed easier access without having to remove the entire "brain" assembly. We also replaced the modified bilge pump motors with 4 Minn-Kota trolling motors with 30 lbs of thrust each, giving quite a bit more kick to the machine. In order to completely eliminate the water issue we also purchased waterproof ESC's that will work submerged.

The machine was designed to house an on-board battery, to minimize tether size and provide ballast. After the requirements were changed to ban on-board power, we removed the on-board battery and used a surface-based car battery modified with an on-board DC/DC converter to provide 12 volts of electricity at 40 amps to the ROV.

We have three tasks to complete, measuring the temperature of water flowing from a PVC pipe, freeing an OSB to allow it to float to the surface, and retrieving the weights trapping the OSB. To measure the temperature, we have a thermometer inside of a guiding device which will be held above the pipe. We will use a large hook to latch onto the OSB and tip it over, allowing the weights to slide off, and then we will snag the mesh weights with treble hooks attached to a collection array. The last two attachments will be viewable through the lower camera while navigation and the thermocouple will be accomplished by the upper camera.

Troubleshooting Techniques

Our troubleshooting was a multi-tiered process that, although slightly inefficient, worked very well. First, when we encountered a problem, we would sit down and discuss exactly what the problem was, and what caused the problem. After this was made clear, we would discuss possible solutions. The most viable sounding ideas would be drawn out on paper, whiteboard, or in CAD. After we had a basic design we would go down to our shop and construct a basic prototype for testing. If, after rigorous testing, the design was flawed, we would go back to the drawing board and start over.

To use an example, our original plan to retrieve the 2lb dive weights entailed use of a PVC pipe scoop. This would simply scoop up the weights off the floor, but as we experimented with a PVC pipe, we realized that the scoop would most likely simply push the lead-filled bags across the pool floor, instead of picking them up. So we scrapped the scoop idea, and experimented with a wider, flatter, scoop, similar to a dust pan, but that suffered the same issues. We decided against another scoop and looked at the weight. A team member who fished a lot came up with the idea to hook the mesh bag with treble hooks because “they grab onto anything mesh.” We then designed an array of treble hooks on the CG/CB line to carry 6 pounds of weight under the ROV.

<u>Challenges</u>

Luckily this years ROV project has gone fairly smooth, but we still had some big issues. First, our method of piecing together the ROV failed pretty miserably. Then we found out we could not have onboard power. Soon after that we had trouble figuring out how to retrieve the “lava samples”

Originally to attach the 2 pontoons together, we used dabs of marine filler around the outside and inside edges of the cross bars, unfortunately the filler wasn't mixed well and turned out rather brittle, causing the ROV to begin to break apart during the regionals. After we returned we ground off all of the filler and simply screwed the pontoons to the cross bars.

After the regional we were informed that we could not have an onboard power supply, which proved to be quite a challenge. Our electronics and “brain” assembly were already wired around having an onboard battery. So we had to remove the battery, disassemble and rewire the whole tether and spend an extra three hundred dollars on a DC/DC converter to take higher line voltage and eliminate the voltage drop associated with distance. This will maintain the same voltage our motors require at a consistent 12.5 Volt 40 amp source at the motor. The DC/DC converter also had to be wired into our assembly, which took another several days.

During the time we spent rewiring the electronics we came across another conundrum. Originally we were going to retrieve the lava samples using a scoop made out of a length of PVC pipe sawed in half lengthwise. One end of the half-pipe would be sealed off with an end cap of sorts, and the other would be covered with a one way flap. The assembly would be fastened to the underside of the ROV, forming a scoop that would pick up and carry the dive weights. But as we piloted the ROV we realized that the scoop would require a level of control that we wouldn't be able to reach, so we experimented with several prototype lava collection devises, including a wide dust-pan style scoop. We also discussed using a claw to drop them into a bag, but we settled onto a device to snag the bags. We screwed several treble hooks along a thin piece of wood and attach the wood to the underside of the ROV. We would drag these hooks along the bottom, where the hook would catch onto the mesh surface of the weights, snagging them, and allowing us to bring them to the surface. The weights also had to be placed on the CG/CB line to accommodate the extra 6 pounds of weight the ROV would be carrying to keep the ROV level and operational.

Future Improvements

Our ROV has several flaws we would like to improve upon sometime in the future. Our underwater cameras could benefit from having two side views in order to become more aware of our environment, as well as replacing our current cameras with higher resolution cameras. Our control system could also be more efficient if we used a Programmable Logic Controller vs. the current radio frequency receiver. Our hooks could possibly be retractable in order to lessen the machine’s drag. It also would be extremely beneficial if we could make our entire ROV lighter, because it is rather difficult to transport and launch. We are considering replacing a battery-based power supply with a hydrogen fuel cell that we purchased this year to install into an ROV designed specifically for it. This would eliminate the power hookup from the surface to slim down our already beefy tether. Unfortunately, do to time, skill, and budget constraints, we were unable to implement many of these ideas this year, hopefully, we will be able to include these next year.

Design Rationale

To Show our method of thinking, we set up a table to break down each of the individual missions

Free the OBS Locate the OBS Descend to the OBS Attach the Hook to the OBS Manipulate the OBS until all the weights Slide off
Collect the lava sample Free the OBS (see above) Move the ROV along the sea floor Retrieve the lava samples Return the ROV to the surface
Measure the temperature of hydrothermal vent fluid Locate and make our way to the hydrothermal Vent Keep a thermometer in the hydrothermal fluid long enough to register temperature View the reading at the surface

Basically, we looked at all the small things we needed to accomplish for each task and designed the ROV and tools around these tasks. We knew immediately we would have to have some kind of propulsion, enough to move the ROV and several more pounds of weight for the OSB and the lava holding it down. So we decided to use rather large motors with more than enough power to do this. Another consideration we looked at, was having the design as modular as possible for future competitions.

As such these are the tools decided on

We needed
1 Large hook to shift the OSB enough to break it loose
1 board lined with treble hooks to snag the and carry the lava samples
1 fork shaped device with the thermal couple on top in order to direct the water flow onto the sensor

The hook is made out of PVC board and is large enough to be able to easily grab a hold of the OBS’s frame. The board is roughly 2”x1”x2’4” and is lined by treble hooks spaced roughly 3” apart, the board is suspended 10” from the bottom of the ROV.

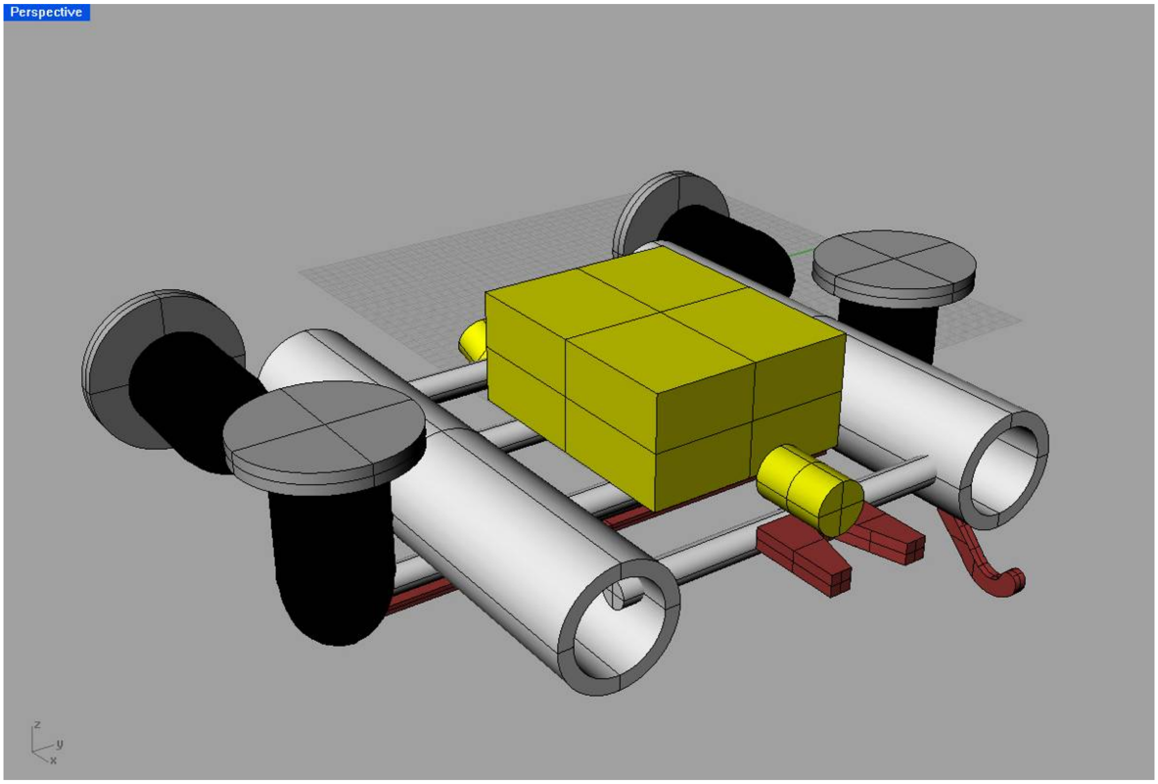
The overall ROV shape and design was designed around housing 4 large minn-kota electric trolling motors at 30lbs of thrust each. 2 motors would be facing forward, and 2 facing down, in order to have maximum control on both the vertical and horizontal axis’s. Our original plan was to house the motors inside the PVC “pontoons”, but after thinking the design over, we chose to move them outside the pontoons in order to achieve maximum efficiency. The motors are mounted to the ROV through use of metal pipes crossing between the two pontoons, in order to provide the ROV with a structural reinforcement as well as giving the motors a stable base.

We chose the 2 pontoon design around the idea of using the pontoons to house flotation / ballast, seeing as having such a wide base for floatation would make it easier to achieve a relatively level machine

We used a pre manufactured drybox to contain the electronics because we originally planned to house an on-board battery inside our electronics housing, but later we found out that that was against competition rules. We now have a 12 volt battery on the surface and a dc/dc converter on the ROV.

This year’s ROV’s control system is rather simple. We have an airplane remote controller with a S-cable carrying the signal down to an RF receiver in the dry box. The RF receiver then sends the signal to the 3 electronic speed controllers, one for the port thruster, one for the starboard thruster, and one for the two vertical thrusters.

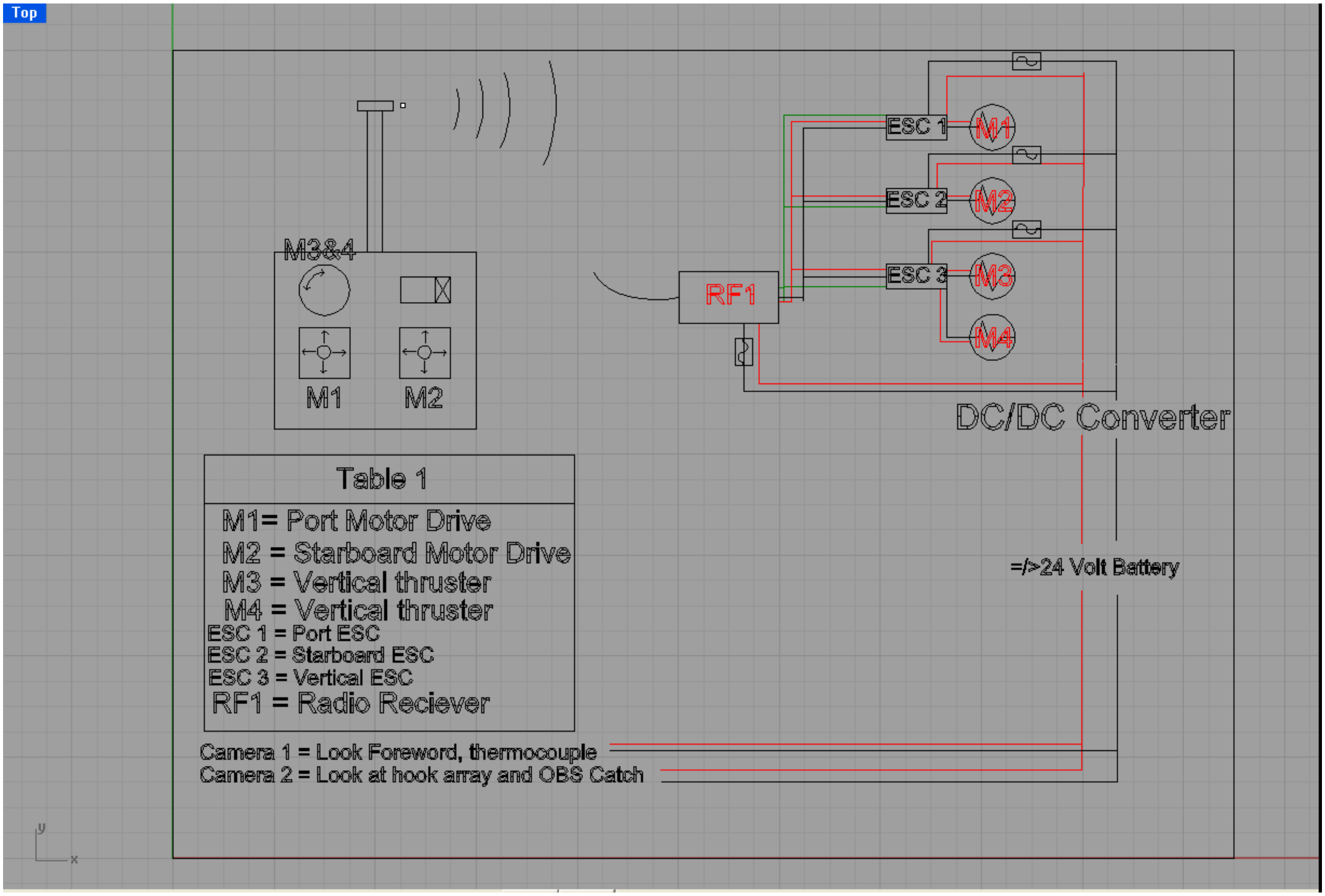
In order to complete the tasks and navigate with optimum efficiency we decided to use 2 cameras. One camera is mounted at the vehicles bow for directional control and navigation, another forward-facing camera is mounted in the lower stern, to allow viewing of the Hook-board and the OSB hook.


Perspective

Budget

Instructor/Sponsor:		George Bradbury		To:	6/31/2008
- Funds	$8000 donation from PB Marine Industries Association				
Date	**Deposit or Expense**	**Description**	**Notes**	**Amount**	**Balance**
2/27/2008	Expense	Boaters world (motors) and case	$8,000.00	$450	$7,550
2/27/2008	Expense	PVC Piping for frame		$ 57.08	$ 7,492.92
3/10/2008	Expense	Battery		$ 41.95	$ 7,450.97
3/10/2008	Expense	ESC's (4)		$ 155.96	$ 7,295.01
4/1/2008	Expense	Cameras		$ 276.88	$ 7,018.13
4/1/2008	Expense	Paint, conduit, couplings, JB weld		$ 26.32	$ 6,991.81
4/23/2008	Expense	DC/DC Converter-Step down voltage		$ 286.00	$ 6,705.81
4/30/2008	Expense	Temperature Probe		$ 71.95	$ 6,633.86
5/1/2008	Deposit	Students	$ 800.00		$ 7,433.86
		Travel Allowance	$ 500.00		$ 7,933.86
5/22/2008	Expense	Plane		$ 4,720.00	$ 3,213.86
	Expense	Lodging		$ 1,750.00	$ 1,463.86
		Lodging		$ 600.00	$ 863.86
		Taxi		$ 300.00	$ 563.86

ROV Controls/Wiring Diagram:



<u>R.O.V's Being Using Used In
Deep Ocean Ridges</u>

R.O.V's are used in deep ocean ridges by the mapping of the sea floor by Bob Embely and his team. During explorations of the ocean floor the team of scientist, geologists, and ***R.O.V*** technicians go over spots by boat and use an ***A.U.V*** attached with sonar's to map the bottom of the ocean. On the second part of the exploration, the team of will use ***R.O.V***'s to take samples and readings of temperatures and the bottom. The teams are in a place that has been scarcely explored. They are searching in a place that has solidified deposits and hydrothermal activity. Because the places that the scientists are studying are in deep parts of the ocean, Divers cannot reach them and they must use ***R.O.V***'s and ***A.U.V***'s.

The ***A.U.V*** or ***Autonomous Underwater Vehicle*** was used the first part of the exploration because they could put it behind a boat and use it to move around and map seafloor without being in any danger. The ***A.U.V*** was programmed to map certain spots without any supervision. The ***A.U.V*** they use can stay down underneath the water for more than a day on batteries witch gives the A.U.V plenty of time to survey the ocean floor in that area. The team also uses ***R.O.V***'s or Remotely Operated Vehicle. The one they used was tethered to a boat and controlled by an operator on the boat that controls the ***R.O.V***. The ***R.O.V*** that the team used; collected samples of sediments on the sea floor, the water temperature and salinity, took water samples with two containers, took samples of hydrothermal liquids, and sediments and organisms a vacuum sucked up.

Another exploration mission that R.O.V's were used for was for a test that the Rhode Island University conducted. They wanted to explore the Black Sea and Agean Sea.
The first part of this exploration mission was to survey the bottom and find any anomalies. The teams found two ship wrecks and explored them with the R.O.V's they built. The teams also found hydrothermal vents but no signs of them being active.
In a new area at the Kolumbo Crater the researchers found that at the deepest it was approximately 505 meters in depth and at the most shallow parts it was approximately 10 meters in depth. When they sent the ***R.O.V***'s down they discovered a reddish orange bacteria blanket that indicated to them that there was active hydrothermal vents nearby.

The teams found a hydrothermal vent field that (thanks to the ***R.O.V.***) could measure the temperature of the water. It was measured to be about 244 degrees Celsius. On the third and final stage of the exploration mission they explored the Black Sea. The team marked 494 targets on their sonar but only got to check 44 of them. Most of the targets checked where just pieces of trash that had been thrown overboard by ships. The team did find two shipwrecks and recorded oxygen levels up and down the water column. The ***R.O.V's*** are valuable parts to any exploration that cannot be done by divers because of depth, length of stay and the ability to take samples of water, sediment, bacteria and can be fitted with many helpful tools on the payload areas.