Stockbridge High School

"Goldfish III"

Making our first appearance in an ROV competition.

***Team Instructor:** Bob Richards

***Team Members:** J.D. Summers, Brandon Mason, Zach Olson, and Cody Allred

Location: Stockbridge High School 416 North Clinton St., Stockbridge, MI 49285

***Listed as seen from left to right**

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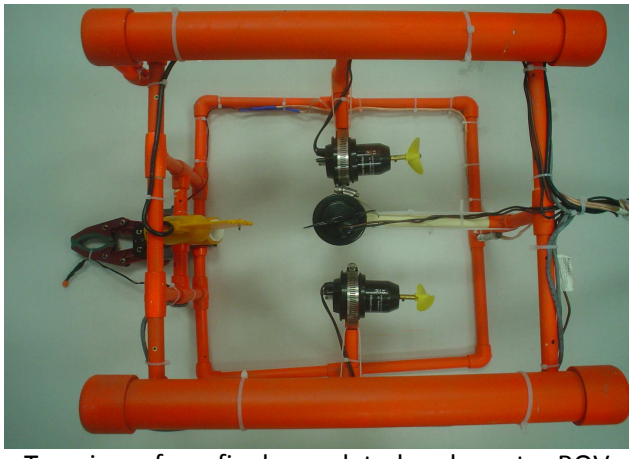
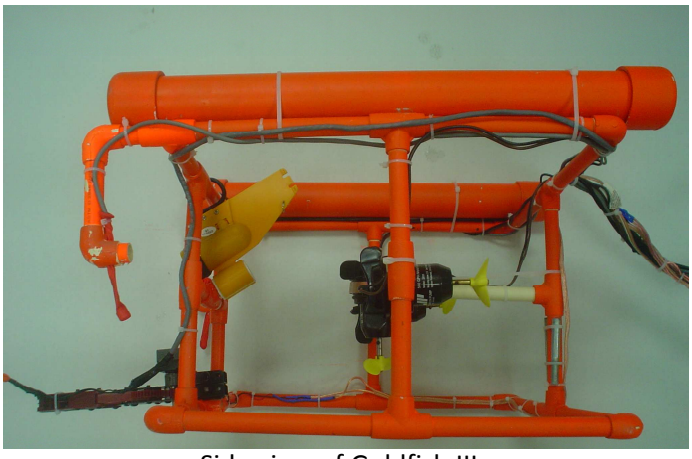
Abstract

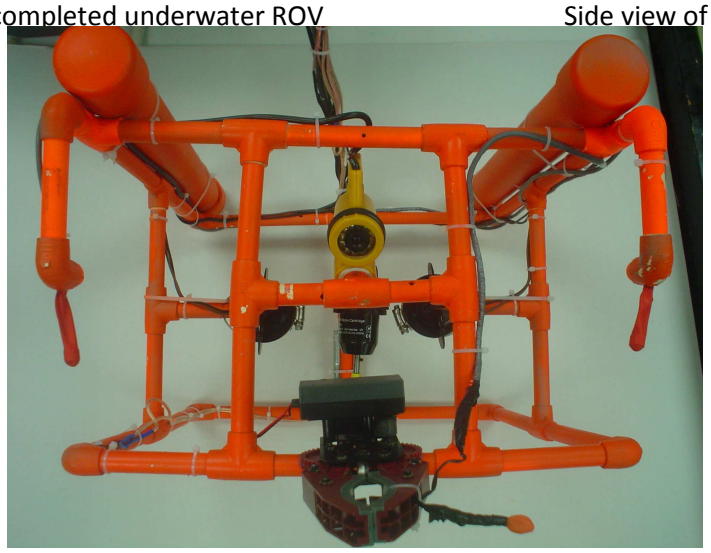
The team looked at the task that we were given and split up the tasks. Each member was in charge of different problems to solve or different areas to focus on. The group of people that was in charge of building the arm was also in charge of designing the robot. Our team's first task was to complete the claw arm and to get it to function properly. After this task, we then built the robot around the arm. While that group was working on the robot and its arm, another member of the team was building a device to fit on the robot that would take the temperature of the water. This team member also helped build a device to listen for sound underwater, or a hydrophone, which also had to be built to fit on the robot. In the real world, robotics engineers also take tasks and split them up. Each task is given to an engineer who specializes in that specific area or given field. Realizing this, our team decided this would be the best strategy.



Top view of our final completed underwater ROV



Side view of Goldfish III



Front view of ROV

Budget

Total Expenditures 1 February to 17 April 2010:

Cost of building the ROV:	$521.97
Cost of attending the Regional Competition:	$481.30
Total Expenditures:	$1003.22

All funds provided by Mr. Richards not the Stockbridge School District.

ROV Bill of Materials

Frame

Item	Price	Quantity	Total Cost	Suppliers	Source of Funds
PVC ½" X5'	$2.58	10	$25.80	Lowes	Mr. Richards
PVC- Elbow ½" PVC 90	$ .39	10	$ 3.90	Byrum Hardware	Mr. Richards
PVC-T	$ .49	19	$ 9.31	Byrum Hardware	Mr. Richards
Hose Clamps	$1.30	3	$ 3.90	Lowes	Mr. Richards
Zip Ties	$7.97	1pk	$ 7.97	Lowes	Mr. Richards
PVC cap	$ .83	4	$ 3.32	Home Depot	Mr. Richards
PVC 2x2x2	$1.75	4	$ 7.00	Home Depot	Mr. Richards

Motors/Thrusters

Item	Price	Quantity	Total Cost	Suppliers	Source of Funds

500 GPH Bilge Pump Motors	$16.99	4	$72.04	West Marine	Mr. Richards
Octura 1250 Plastic Prop	$ 2.99	10	$44.89	Funrcboats	Mr. Richards

Payloads

Item	Price	Quantity	Total Cost	Suppliers	Source of Funds
VEX Claw	$19.99	1	$19.99	Vex Robotics	Shop Stock
VEX Motor	$19.99	1	$19.99	Vex Robotics	Shop Stock

Electrical System

Item	Price	Quantity	Total Cost	Suppliers	Source of Funds
Speaker Wire	$19.99	4	$79.96	Kmart	Mr. Richards
250’ Cat 5 cable	$49.97	1rl	$49.97	Lowes	Mr. Richards
Min. plug black	$ 2.99	2	$ 5.98	Radio Shack	Mr. Richards
Battery holder C	$ .99	2	$ 1.98	Radio Shack	Mr. Richards
Battery Holder AA	$ .99	1	$ .99	Radio Shack	Mr. Richards
Battery Holder AAA	$ .99	1	$ .99	Radio Shack	Mr. Richards
Buzzer	$ 3.49	1	$ 3.49	Radio Shack	Mr. Richards

3.6KAZ Piezo Buzzer	$ 4.49	1	$ 4.49	Radio Shack	Mr. Richards
1/8 monoplug	$ 6.99	1	$ 6.99	Radio Shack	Mr. Richards
Electric microphone element	$ 3.79	4	$ 15.16	Radio Shack	Mr. Richards
Inline fuse holder	$ 2.69	2	$ 5.38	Radio Shack	Mr. Richards
Binding Post	$ 2.99	1	$ 2.99	Radio Shack	Mr. Richards
DPDT Toggle Switch	$ 3.69	6	$ 11.07	Radio Shack	Mr. Richards
Project Box 7x5x3	$ 5.99	2	$ 11.98	Radio Shack	Mr. Richards
Project Box 8x6x3	$ 6.99	1	$ 6.99	Radio Shack	Mr. Richards
AAA batteries	$ 5.99	1pk	$ 5.99	Walgreen's	Mr. Richards
C batteries	$ 6.99	1pk	$ 6.99	Byrum Hardware	Mr. Richards
Copper tubing ¼"(3/8"OD)X2'	$ 5.97	1	$ 5.97	Lowes	Mr. Richards
50' Audio Cable	$ 9.89	4	$39.56	Radio Shack	Mr. Richards
Pocket speaker/amp	$14.99	2	$29.98	Radio Shack	Mr. Richards

Total cost to build ROV: $521.97

Misc. Expenses

Item	Price	Quantity	Total Cost	Suppliers	Source of Funds
Cord Reel	$ 6.92	1	$ 6.92	Lowes	Mr. Richards

Foam Board	$ 12.99	1	$ 12.99	Office Max	Mr. Richards
49 gallon tote	$ 17.99	1	$ 17.99	Kmart	Mr. Richards
Foam Board	$ 3.99	3	$ 11.97	Staples	Mr. Richards
Poster Tape	$ 4.29	4	$ 17.16	Staples	Mr. Richards
Brother – tape	$ 21.99	1	$ 21.99	Staples	Mr. Richards
DVM-60 tape	$12.99	1	$ 12.99	Staples	Mr. Richards
Poster Board	$ 4.99	2	$ 9.98	Michaels	Mr. Richards
Stock Tank Round 3'x2'x8'	$204.99	1	$204.99	Tractor Supply Company	Mr. Richards
Total Costs paid to date for ROV and regional competition prep: As of 17 April 2010			**$838.95**		Mr. Richards

Great Lakes Regional Competition 17 April 2010

Item	Price	Quantity	Total Cost	Suppliers	Source of Funds
Lodging 4/16/10 Days Inn	$160.04	2 rooms	$160.04	Days Inn	Mr. Richards
Dinner 4/16/10 @ Pizza Hut	40.23	Dinner	40.23	Pizza Hut	Mr. Richards
17 April 2010	**Cost of Competition paid**		**$164.27**		**Mr. Richards**

MATE International ROV Competition Expenses:

Item	Price	Quantity	Total Cost	Suppliers
Shipping(ROV)			$370.00	U.P.S.
Air Fare round trip Flint to Honolulu, HI	$3,522.00	5	$3,522.00	Delta Airlines
Honolulu – Hotel	$170.00	2	$340.00	Hale Koa
Flight to Hilo	$75	5	$375.00	
Lodging at UH-Hilo	$408.00	2	$408.00	UH-Hilo
Meals-Hilo	$315.00	5	$315.00	UH-Hilo
Flight to Honolulu	$75	5	$375.00	
Honolulu – Hotel	$160.00	2	$320.00	Hale Koa
Total Cost to go		**$5,655.00**		
Shipping		**$ 370.00**		
Total		**$6,025.00**		

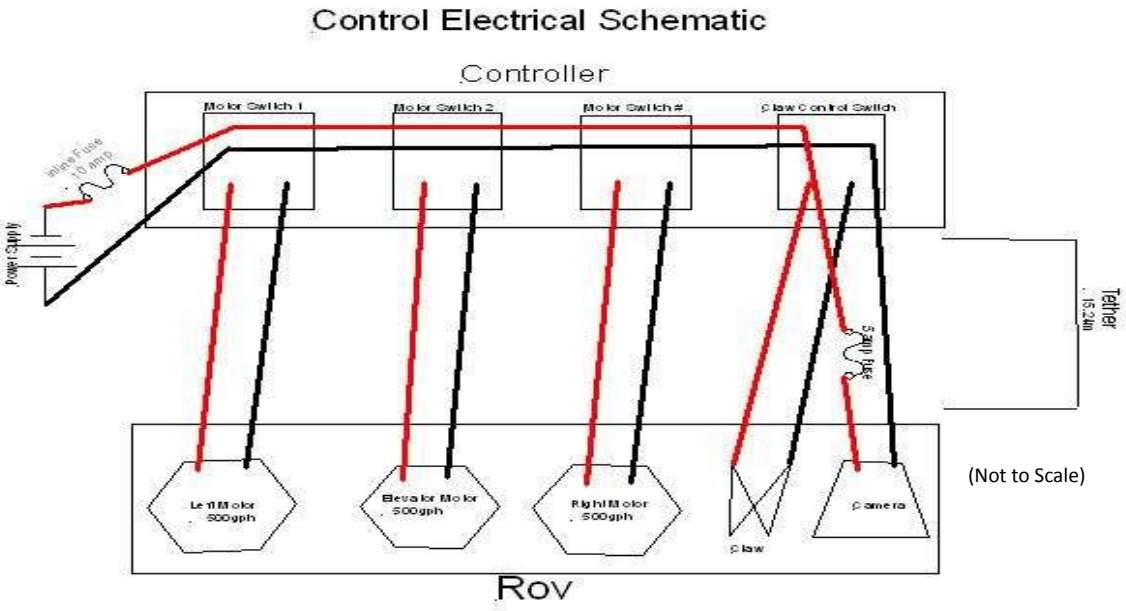
Income Statement/Source of funds

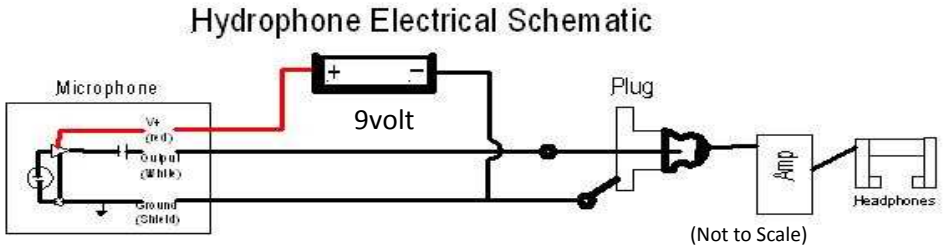
Date	**Name of donator/source of funds**	**Amount**	**Balance**
4/17/10	Robotics Account Balance	772.04	772.04
4/23/10	Stockbridge Area Education Foundation	1,000.00	1,772.04
4/29/10	The Abbott & Fillmore Agency Inc	100.00	1,872.04
4/30/10	Roberta And Gary Ludtke	100.00	1,972.04
5/04/10	Richard and Kathleen Mullins	100.00	2,072.04
5/04/10	William and Andrea Stickney	120.00	2,192.04

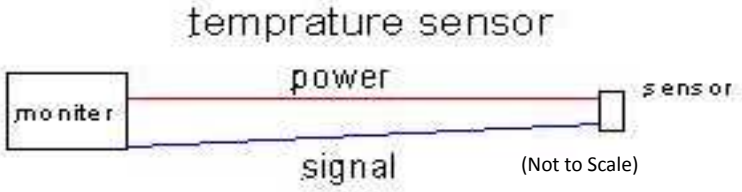
5/06/10	Cash Donation Jars	70.00	2,262.04
5/07/10	Richard and Karen Stahl	35.00	2,297.04
5/07/10	Cash Donation Jars	70.50	2,367.54
5/10/10	Pratt-Whitney	500.00	2,867.54
5/10/10	Mr. Bruce Brown	100.00	2,967.54
5/12/10	Cleary's Pub	100.00	3,067.54
5/12/10	Watters & Sons Farms	100.00	3,167.54
5/12/10	Trinity Pentecostal House of Prayer	100.00	3,267.54
5/12/10	Verglenda Salyer	200.00	3,467.54
5/12/10	Cash Donation Jar	12.50	3,480.04
5/13/10	Cash Donation Jar (honors night)	81.00	3,561.04
5/14/10	High School (Mr. H.)	500.00	4,061.04
5/14/10	Cash Donation Jar	60.50	4,121.50
5/14/10	Good Shepherd Mission	100.00	4,221.54
5/14/10	Mary Singer	20.00	4,241.54
5/14/10	Nancy Kaelin	25.00	4,266.54
5/14/10	Patrick Wright	100.00	4,366.54
5/17/10	American Legion Post 510 (Legion Riders)	100.00	4,466.54
5/18/10	Greg and Charlotte Craft	200.00	4,666.54
5/18/10	Mark K. Barkley D.D.S.	50.00	4,716.54
5/18/10	Cash Donation Jar	7.50	4,724.04
5/19/10	Midway Convenience Storage Inc	200.00	4,924.04
5/19/10	Stockbridge Education Assoc.	200.00	5,124.04
5/19/10	Cash Donation Jar	34.00	5,158.04
5/24/10	Stockbridge Area Chamber of Commerce	100.00	5,258.04

5/24/10	Kenneth & Cynthia Skrent	20.00	5,278.04
5/24/10	Audrey Price	50.00	5,328.04
5/24/10	Mike Sauve	10.00	5,338.04

Electrical Schematics







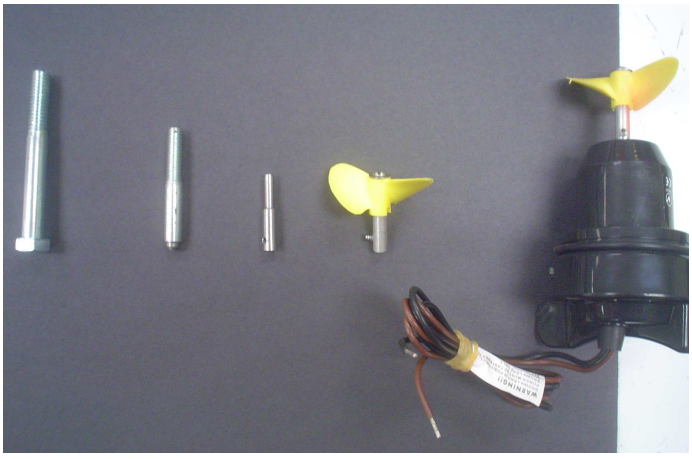
Design Rational

Frame

The “Goldfish III” frame is constructed from 1/2” CPVC pipe with holes drilled about every 2” in order to allow the ROV main frame to quickly fill with water and submerse into the water. The robot is cube shaped to optimize maneuvering, weight distribution, and stability. A pair of sealed flotation pods full of air are mounted on the top of the ROV frame, one on each side, providing buoyancy. These flotation pods are made out of 1-1/2” PVC with a 1 1/2” PVC cap on each end creating a waterproof seal.

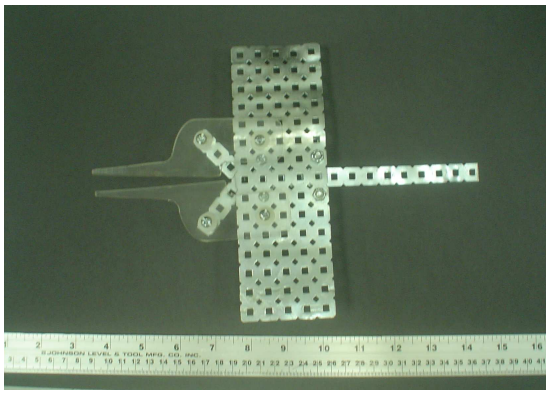
Thrusters

Our ROV uses three separate bilge pump motors rated at 550 GPH each to maneuver throughout the underwater course. We machined a custom prop shaft adapter out of a bolt for each motor, modifying its original shaft to fit a propeller on the end of the prop shaft. All three pump motors are located in the center of our ROV to protect the props from being caught on the tether or damaged in any way. The motors are arranged so that there are two motors designated for horizontal movement. The third motor controls all vertical movement of our ROV from the dead center of its cubic shape.

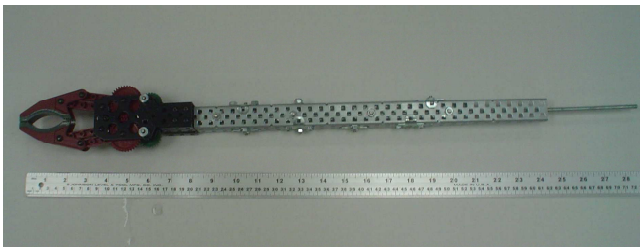


Manipulator Arm

In order to complete some of the tasks, we had to design and create a claw that would grab objects and hold them while being maneuvered. This was a long and tedious process, taking a lot of reengineering, rethinking, and careful planning. Working around size restraints and mechanical challenges, we finally managed the task.



Based on research on the Internet, we came up with a design influenced by Internet models. Our first prototype was created completely from scratch out of plexi-glass and metal plate.



After struggling with this idea for a short time, we changed our idea to using a vex robotics claw with a threaded rod and screwdriver motor. This idea would have worked but was more difficult than necessary.

We created our final model of claw out of a vex robotics claw along with a vex robotics motor. At our first competition this claw worked spectacularly, opening and closing smoothly through the water, maintaining its position and providing just enough torque to squeeze objects with a tight grip without crushing or damaging the object or its own structure.

Systems

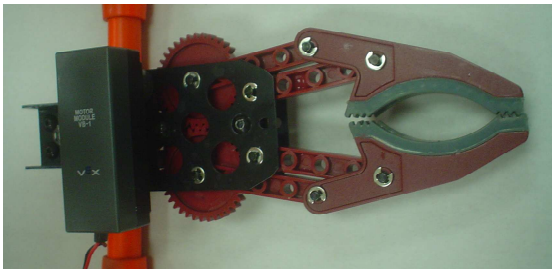
LED Camera

The camera contains LED lights to help see under water. Our biggest design problem with our camera was positioning it on our ROV. Our first position we started out by mounting the camera on the top of our ROV but soon realized we wouldn't be able to monitor the actions of our claw. We then repositioned the camera by rotating it around while still on the top of the ROV; this way we could see our claw and in front of the ROV but everything was upside down. We finally positioned our camera lower inside the front of the ROV so we could see in front and monitor claw functions without being upside down. With a wide-angle view, the camera is specifically made for use underwater. The camera is mounted angled down so we can see in front of our ROV as well as the tip of our claw.

Hydrophone

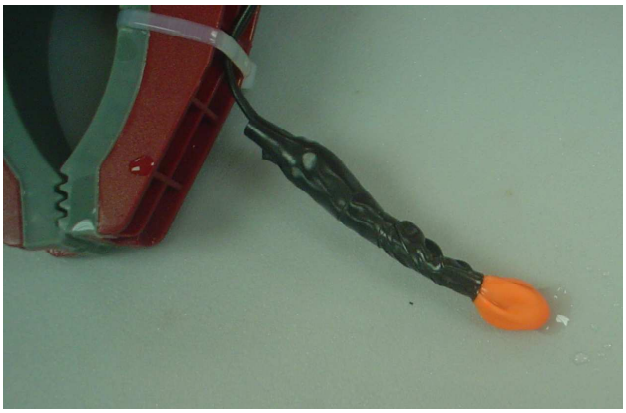
Our ROV contains two Hydrophones, or listening devices, to detect which site is producing the rumbling and place the High Rate Hydrophone at this site. Our Hydrophones are constructed of a balloon, sealed with hot glue. Inside of this balloon is a condenser microphone element connected to a two conductor with shield audio cable. At the other end of the audio cable there is a phone plug and 9 volt battery pack. Each phone plug, from either hydrophone, is connected into its own mini audio amplifier/speaker (powered by its own 9volt battery). For use in loud areas, we also have Audio headsets to listen to hydrophones. Our Hydrophones are placed in the front right and left corners of our ROV. We have two hydrophones to compare sounds coming from either one and decipher from which direction sound is coming. This is our modified version; our original version incased the microphones inside of film canisters filled with oil and surrounded by foam microphone covers. We decided to change our design because the oil and foam muffled the sound in the water too much.

Payload Tool



The claw on our ROV comes from a vex robot. Our Instructor, being a robotics teacher, was able to loan us this claw from his class materials. Operated by a VEX-RC VB-1 Motor, the VB-1 motor is a 7.5 volt motor recieving power from a 12 volt marine battery stepped down with a variable resistor. The whole claw assembly is mounted fixed to the bottom of our Rov, so we can pick up crawlers from the pool floor, as well as open wide enough to grasp other obstacles needing manuvering.

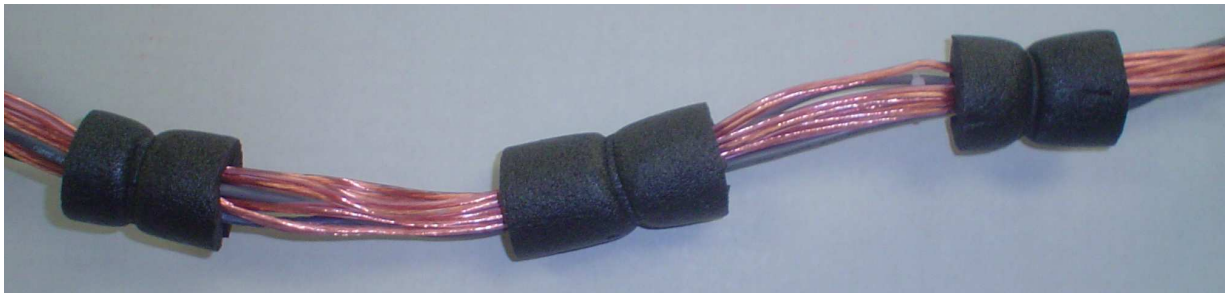
Temperature Sensor



Our temperature sensor is constructed of an indoor/outdoor thermometer. We encased the whole sensor in a balloon and sealed it with hot glue and electrical tape. The sensor is attached to category five wiring, which runs back to the digital read out monitor.

Tether

Our tether contains nine separate cables, zip-tied together for better organization, all running from the ROV to the control box, audio unit, and power source. Periodically, foam pieces are zip tied to the tether to keep it above the ROV and out of the way of moving parts. Safety features in the tether consist of an inline fuse and heat shrink and/or electrical tape over all wire connections.



Challenges

Our team over came multiple challenges, but our biggest struggle was overcoming short amounts of time to work together on our ROV and limited teacher mentoring. Work time consisted of three team members spending an hour and a half in class working together, but the instructor couldn't guide these members because he was teaching another class at the same time. The other two members worked during a different block of the day, again, with limited teacher help. Another large challenge our team had to deal with occurred because our school district doesn't have a pool, so our team had to test our ROV in a cattle-watering trough that we purchased and moved into our classroom.

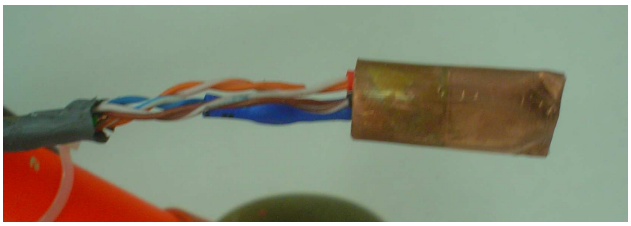
Our ROV being tested in the watering trough we used at our school

We come from a pretty small school. We really do not have very much funding for our school let alone for the advanced robotics team. Most of our funding came out of our instructor's pocket. All the parts that we had to get or the ones that we broke he paid for. We did not ever think that we were going to win the regional competition because this was our first year ever doing it. It was a real reality check when we were told that we had actually won the competition. On the five-hour ride back home we brainstormed ways to raise money. It really hit home that we had a lot of work to do when Mr. Richards came back with the estimated cost for the team to travel to Hawaii a total of $8,000 dollars. It was a big challenge we were going to take on. We dove in headfirst and haven't looked back yet.

Trouble shooting

- Stating the problem clearly
- Collecting information
- Developing possible solutions
- Selecting the best Solution
- Implementing the solution
- Evaluating the solution

One trouble shooting process we endured was in creating our temperature sensor. We used alligator clip wires and amp meters to test connections and decipher between positive and negative. A general trouble shooting process that we used was trial and error. This was especially used in getting the ROV neutrally buoyant in the water.



Our original Temperature sensors including resister incased in copper tubing.

Future Upgrades

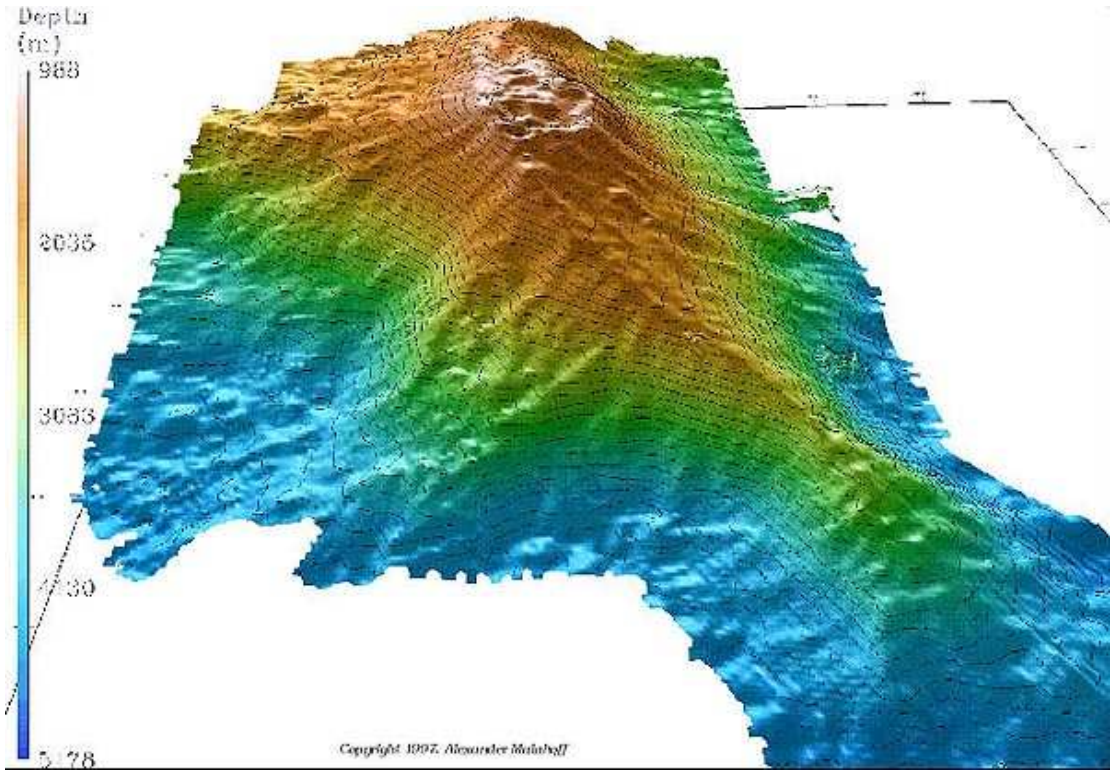
One possible upgrade for ROV would be to attach our claw to an extended arm that was maneuverable outside of moving the whole ROV. Also, we would like to use faster thrusters allowing us to maneuver quicker through the course. We thought about also changing our control system, by using variable switches because as of now we use strictly on/off switches that either give motors full power or no power. We could also add shrouds around the props of each thruster, funneling water directly to the props allowing for more efficient use of thrusters. These shrouds help protect propellers from external damage and prevent tether entanglement.

Lessons Learned

Being a first time competition team, we learned a lot of valuable lessons; for instance, don’t wait until the last minute to get things done and be more efficient with time usage. Always read directions thoroughly and investigate the problem at hand. As an example, we didn’t read the specifications of underwater mission structures in order to recreate our own to practice with.

Loihi Seamount

Ocean



explorer.noaa.gov

The Loihi Seamount is an active undersea volcano located off the southeast coast of the Big Island of Hawaii. Rising more than 3,000 meters above the seafloor, Loihi is the newest volcano in the Hawaiian-Emperor seamount chain. ROV have been created to dive to the sea floor and reconnect communications to data taking components already placed, as well as take thermal readings searching for hydrothermal vents, take samples of new bacteria and relocate the HRH near active volcanoes which is deciphered from low rumblings. The Scenario recreated in the pool is designed to mock actual activities of engineers being preformed on the actual underwater seamount.

Reflection

One of the biggest things that we would have done differently is we would have read the directions before we started a project. There were many sensors that would have been done a lot easier if we had read the directions before we started rather than just looking at pictures. Another thing that we would change is being able to work with Mr. Richards more. We were unable to work with him more because he had a class to teach at the same time that we were working. If we could, we would have tried to start the project earlier so that we had more time to perfect our ROV and so that we could have made it the way we envisioned it when we heard about the competition.

When first hearing about the ROV competition, all team members knew little or no information about what an ROV was. After doing some research and figuring out what they were, how they worked, and what they were used for, our team spent some time working with a fourth grade class in our school district, educating them about some robotics and sharing the knowledge and understanding on the subject. They are currently making simple ROVs; we will be going to the pool in the neighboring community of Chelsea on May 26th.

Teamwork

In order to develop our teams ROV we assigned each member a specific task; this helped our team stay on task in the time crunch we had in preparing for the first regional competition which was held in Alpena, MI. Each member's duties were as follows:

JD Summers- Frame design and assembly

Zech Olson- Wiring controller and tether

Brandon Mason- Buoyancy of the ROV, and the Manipulator arm (claw)

Cody Allred– Hydrophone and temperature sensor

Zach Fallot- Machining thruster/ prop connections

Madison McClelland- Advertising, Public relations, news releases and news paper articles

Acknowledgements

Our team would like to acknowledge the guidance and support of Mr. Watson, a shop teacher at our school, who supplied us with work tools, and Mr. Nichols, an elementary teacher in our school district. We would like to make an additional acknowledgement to the MATE center. The team would also like to thank Zach Fallot for assistance with machine work and Madison McClelland for helping with advertisement and public relations.

We would like to thank the following groups and individuals for donations toward the funding of our trip:

- Stockbridge Area Education Foundation
- The Abbot & Fillmore Agency
- Roberta and Gary Ludtke
- Richard and Kathleen Mullins
- William and Andrea Stickney

- Richard and Karen Stahl
- Pratt-Whitney inc.
- Mr. Bruce Brown
- Cleary’s Pub
- Watters & Sons Farms
- Trinity Pentecostal House of Prayer
- Verglenda Salyer
- Stockbridge High School
- Good Shepard Mission
- Mary Singer
- Nancy Kaelin
- Patrick Wright
- American Legion Post 510
- Greg and Charlotte Craft
- Mark K. Barkley D.D.S.
- Midway convenience Storage Inc.
- Stockbridge Education Association
- Stockbridge Area Chamber of Commerce
- Kenneth & Cynthia Skrent
- Audrey Price
- Mike Suave
- And everyone who donated to cash donation jars

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Bohm, Harry, and Vickie Jensen, eds. *Build Your Own Underwater Robot and Other Wet Projects*. 9th ed. Vancouver, B.C. Canada: Westcoast Words, 2007. Print.