2010 ROV Technical Report

ROV SEA

Socastee High School's SEAL Club

Team Socastee

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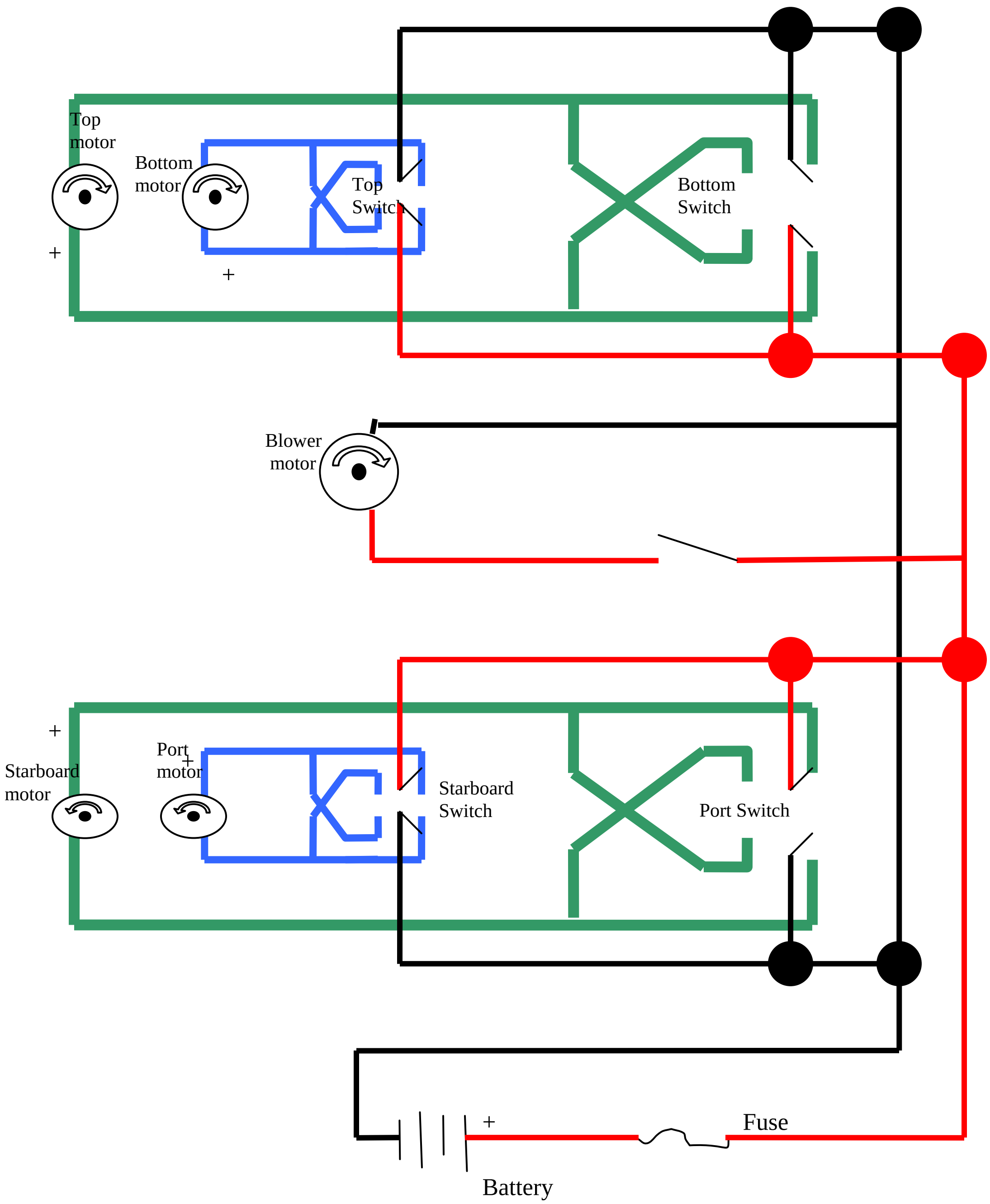
Abstract

Described within the following technical report are the design, construction, and implementation of Socastee High School's 2010 ROV being entered into the MATE ROV competition in Myrtle Beach, South Carolina. The design and construction of this ROV was carried out by a team of five high school seniors and juniors while being overviewed and sponsored by two mentors that work within the science department at Socastee High School. The process involved within the creation of such a vehicle spanned over the course of three months beginning in January with the designing of the machine. The missions by which the ROV was designed and constructed around were based, this year, on those missions likely to be found implemented by marine researchers about the Loihi seamount located in Hawaii. The missions include the resurrection of HUGO, the collection of new samples of crustaceans, the sampling of new vent sites, and the collection of a sample of bacterial mat. Testing of the ROV in water was done regularly throughout its construction in order to assure complete efficiency. The final ROV includes five bilge pumps located on a PVC pipe frame. Four of the bilge pumps are fixed with six inch propellers used to control the movement of the vehicle while the fifth bilge pump is used to displace water, pushing the "crustaceans" into a holding area for task #2. Also included on the vehicle are three plastic prongs: two are used for the picking up and moving of objects for the resurrection of HUGO task and the third contains the thermometer needed to sample the water vent temperatures.

Budget/Expense Sheet

Item	Unit Price (US$)	Quantity	Cost (US$)
½ " PVC (10ft sections)	1.32	2	2.64
½ " PVC 45$_o$ coupling	0.51	5	2.55
½ " PVC 90$_o$ coupling	0.37	9	3.33
½ " PVC "T" coupling	0.28	16	4.48
½ " PVC "+" coupling	0.87	4	3.48
½ " pipe insulation	0.97	2	1.94
¾ " plastic tubing	0.84	3	2.52
¾ " plastic tubing 90$_o$ coupling	0.62	2	1.24
¾ " plastic tubing "T" coupling	0.83	2	1.66
Bilge pumps	29	4	116
18ga speaker wire	0.35	120	42
8" cable ties (500pk)	13.61	1	13.61
Stainless steel bolts	1.08	3	3.24
Stainless steel washers	0.4	6	2.4
Stainless steel nuts	0.4	3	1.2
White lattice cap	6.97	1	6.97
Thermometer	3	1	3
Camera/Moniter	99	2	198
Chicken wire	6	1	6
Thrusters	29	4	116
Propellers	2	4	8
Project box	3.69	1	3.69
Toggle switch	3.79	5	18.95
Total		562.9	

Electrical Schematic



Design Rationale

Frame: PVC was chosen because it weighs less than many other materials and is also easy to shape and put together. We were also able to cheaply purchase pre manufactured parts with different angles and shapes.

Tether: For the tether we used speaker wire because it was easy to work with and also fairly cheap. We used a nylon rope in case of an emergency and also to relieve the stress off of the wires. In order to make the tether buoyant, we used foam and zip ties.

Buoyancy: Through trial and error we added foam to the ROV to make it both neutrally buoyant and stable.

Propulsion: We used 4 Bilge pumps for our propulsion system because they were already waterproof, and contained a simple wiring system. They also gave us the ability to move backwards and forwards by reversing the currents.

Camera: We placed a camera on the top of the ROV in order to give us a 3rd person view of the ROV and we placed another camera on the bottom in order to see all of our props while in motion.

Arm: We used a nylon block and rubber bands in order to make an arm that would easily pick up the PVC pipes and not release them while we were approaching the surface.

Challenges Faced

One of the many challenges our team faced was the placement of the thermometer we use to take the various temperatures. At first, we made an attachment that went out in front of the ROV mid way down the vertical arm and the face was visible in the peripheral vision of the camera. Out of the water we thought we might need to bring the arm in closer but once we put it in the pool, the water magnified the numbers just enough so that we could tell where the needle was. This position worked fine until we constructed an arm to pick up the PVC pipes. At first, we were going to have a physics teacher come in and explain how pneumatics worked and attempt to build a pneumatic arm but we decided against that because there was too much risk of the tube leaking and dropping the pipe. We then built a prototype out of legos and came up with the idea to use rubber bands to hold the two pieces closed. After we built the arm, we had to decide where to place it so that it would not throw off the buoyancy too bad. We decided to attach it to the piece of PVC pipe the thermometer was on and put the thermometer through the arm. This was ok until we were test-driving the ROV and discovered that the pilot could not see the end of the thermometer and therefore could not see where to drive the ROV to get an accurate temperature reading. After some discussion, we concluded that moving the thermometer would be the easiest solution and moved it up to the top of the ROV on the other side as the arm so it would balance the weight better. Since we put it on top of the ROV, the attachment had to be removable so we could take it off before we enter the cave and we changed which camera the pilot uses to measure the temperature.

Troubleshooting

Many problems were encountered during the process of building the ROV but when a problem arose, our team took simple steps to fix them. If a propeller or pump was not functioning right, we would first test the wires to make sure the connection was still in tact. Then, we would use deductive reasoning to determine the exact problem and decide as a group what the most time and cost efficient solution was. New ideas were drawn out, worked out on the board, and discussed until a consensus was reached. At the end of each meeting, it was decided what still needed to be done so that at the next opportunity, anyone could work on the ROV. If a new attachment was added and at the pool it did not work as imagined, at the next meeting or opportunity a team member would make any adjustment he/she felt would improve the device and then it was tested again. This trial and error process has helped us determine the best way to achieve our goal and to determine what we need to improve.

Lessons Learned and Future Improvements

In building this ROV, the team members learned how to solder wires together and use power tools such as a Dremel tool or power saw correctly. We needed to add new buttons and switch some of the wires on the switches around because they were the opposite way. We had to clip the wires, strip them, and solder them together and sometimes they still did not work so we had to remelt the solder to break them apart and start over. None of the team members had soldered wires before so we each practiced on old wire and then everyone soldered at least one of the wires. We used the Dremel tool and power saw to cut and shape the pieces for the arm. We learned the proper safety for operating these tools.

We faced many challenges while building the ROV but we feel that in the future years to come we hope to improve many problems we faced. We hoped to decrease the time it takes to build the ROV and its features in the years to come because of the knowledge we gained throughout this process of building the ROV. Instead of taking time in learning how to solder, or how to attach wires and reverse bilge pumps we will be able to put more time into making the ROV and thus giving us more time to practice in the water. We also feel that since we overcame challenges such as the bilge pump and the thermometer we would be able to cut time out of debating on what to do. We also faced a problem with the amount of time we had to practice due to the lack of availability of pools which would have helped us hone in on our skills and techniques in operating the ROV. We hope in the future to gain more access to pools and other water 10 sources to practice and hone in on different techniques and skills needed to operate the ROV. One major improvement to the ROV itself would be a dimmer switch. We had goals to obtain one so that we could control the engine power for smaller areas, but we were never able to successfully include one. Another, more minor, addition would be propeller guards.

We had difficulty with the wires becoming entangled and we believe propeller guards would greatly enhance our future performance.

Loihi Sea Mount.

The Hawaiian-Emperor seamount chain is a string of over 80 volcanoes that stretches more than 5,800km. Loihi is the newest active, undersea volcano in this chain and is located approximately 35km off the southeast coast of the Big Island of Hawaii. This chain is formed by the Pacific plate moving over the Hawaiian hotspot, which is an area within the plate where a narrow stream of hot liquid mantle moves up towards Earth's surface as the tectonic plate passes over. Loihi began forming around 400,000 years ago and is expected to begin emerging above sea level about 10,000-100,000 years from now. At its summit, the seamount stands more than 3,000m above the seafloor. It was initially believed that Loihi was an old, dead volcano. However, researchers soon discovered that it is, in fact, a young and active volcano covered with lava flows and actively venting hydrothermal fluids. When Loihi rumbled to life, it triggered more than 4,000 earthquakes, which is the most ever recorded for a Hawaiian volcano. As a result of these earthquakes, the southern portion of Loihi's summit collapsed. This formed a crater 1km across and 300m deep with extremely steep walls. It was named Pele's Pit, after the Hawaiian goddess of the volcano. Temperatures could range from 30°C and 200°C. The venting fluids of the seamount are especially high in both iron and carbon dioxide, which is the ideal environment for sulfur-oxidizing bacteria to survive. In 1997, HUGO(Hawaii Undersea Geological Observatory) was installed on the summit of

Loihi. It was the first undersea volcano observatory, giving scientists real-time seismic, chemical, and visual data about the state of the seamount. More than 40km of fiber optic cable is used to link HUGO to shore. After several complications with the cable, HUGO was shut down and is no longer operational. The purpose of HUGO was to relay data from HUGO to the Big Island of Hawai'i for real-time monitoring of the volcano's behavior. The summit platform includes two well-defined pit craters and low-temperature hydrothermal venting. The initial discovery of deep-sea hydrothermal vents at the Galapagos Rift has resulted in a decade of exploration and experimentation. Until recently, these deep-sea vents were known only at, or near, plate boundaries, but recent sea-floor camera survey programs have indicated that hydrothermal vents are present at the summit of Loihi Seamount. Magmatic processes provide the driving mechanism for hydrothermal circulation through oceanic rocks. Interactions between hot rock and seawater give rise to venting of hydrothermal fluids. (HURL), The Hawaii Undersea Research Laboratory, NOAA’s National Undersea Research Center for Hawaii and the Western Pacific, conducts regular monitoring and supports research projects that study Loihi. The ROV Pisces V, the workhorse of scientists from HURL, has made over 50 dives during its lifetime. It has collected data, samples, deployed instruments, and repaired HUGO. Our ROV will be expected to complete these same tasks. It must resurrect HUGO, collect samples of a new species and the bacterial mat, and sample a new vent site.

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Reflections

Throughout this experience we all learned some valuable skills. Some of us learned how to use power tools and how to repair a fuse while others learned how to work together as a team and communicate. We were faced with many challenges and together we were able to overcome them despite our differences in opinions and ideas. This experience helped many of us learn some valuable life skills and also gave some of us a chance to do what we love. All in all we believe that this experience was a success due to the fact that we all learned something new and had a good time doing it. When I signed up to join the SEAL clubs ROV team, I really had no idea what I was doing. I had made a ROV for a marine science class but that was with much guidance and a simple design. Before I started working on this I did not even know how to use a power drill but now I can solder wires, use a power saw, and melt and manipulate plastic parts. This project has also allowed me to branch out and become friends with people I never would have met. When we first started, I knew one or two people on the team and now we are all friends and have learned to work well.

~ Meg Oshima

I first joined the ROV team because I was bored and wanted something to do after school. After several meetings, I grew a much greater interest in the project. The entire experience was one I won’t forget. Though there were some difficulties, I found the process to be nothing but fun. I’m thankful for all the skills I’ve learned and the friendships I’ve created.

~ Dougie Warstler

I stumbled upon the ROV my freshman year in high school and have been with it since. It was a project I could never have envisioned myself doing but have found that it is something I love. After all of the work we put into this years ROV, I see it almost as my child. It is going to be hard to go our separate ways.

~ Hunter Robertson

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Acknowledgements

We would like to thank everyone that has donated the tools and supplies we needed to build the ROV. A big thanks to Mrs. Stone, who helped us get to a pool whenever we needed it and who was so supportive. We could not have gotten in the practice time we needed without you. Thanks to the Canal Street Recreation Center for allowing us to frequently use one of their lanes for practice. It is great to know that we have somewhere to go to practice. And thanks to anyone who’s offered any help or suggestions. We really appreciate all of the help and support we have gotten on this project. We could not have done it without the generosity of so many people. Thank you.