Subaquatic Solutions

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Project Management

Tasks for *fill in Month*

Check in *12/12 completed*

✓	Date Task was entered	Task	
			Build Team Month something to celebrate
	7/9	Build Task 1	Build Team Month Task (completed)
	9/20	Build Task 2	
	9/9	Build Task 2	
	7/23	Long term Task (2 month task) on month 1	Build Team Long Term Task (completed)

			Programming Team Month something to celebrate
	7/9	Programming Task 1	Programming Team Month Task (completed)
	9/20	Programming Task 2	
	9/9	Programming Task 2	
	7/23	Long term Task (2 month task) on month 1	Programming Team Long Term Task (completed)

			Marketing Team Month something to celebrate
	7/9	Marketing Task 1	Marketing Team Month Task (completed)
	9/20	Marketing Task 2	

9/9	Marketing Task 2	
7/23	Long term Task (2 month task) on month 1	Marketing Team Long Term Task (completed)

Design Rationale

Engineering Design Rationale

The ultimate goal that our company is working to achieve is to use our functional ROV system to help remove plastic waste and restore both freshwater and marine ecosystems. Our ROV system vehicle consisted of a frame with four thrusters, a camera, and two grippers, as well as a video display box to be able to see the camera as the robot completed several tasks and an Acrobatics Manual Dual Servo to control the claw of the ROV system.

When the team reunited after over a year of being apart due to COVID, the team decided to first test out different types of frames that could be used for the ROV system. We decided to use Sabertooth controllers that were adapted from previous years to control our thrusters, camera, and grippers. Our team decided to add two grippers to our ROV system to remove the eel trap, coral fragments, and the old power conductors in the designed area, as well as collecting the samples of sponges and returning them to the surface. Lastly, we decided to use 3D-printed thrusters so there would be exact measurements that we could control so that the movement of the ROV system would not be off, and we did multiple experiments in our small pool to test how much buoyancy foam we needed and where the thrusters should be placed. We adjusted each component we needed to after these tests, tweaking the design and sanding down the shrouds as needed. All of these meticulous details added to our ROV system helped ensure that it would be able to complete tasks at peak performance, and would be able to serve as a model of ways that we can mitigate the amount of plastic in our water and clean our coral and waterways for future generations.

Innovation

This year, Subaquatic Solutions has strived to make Shelby as innovative as possible. We have worked to lessen the cost of building our robot, while also working to improve the functionality of Shelby. A major way we have done this is by building Shelby's frame with PVC pipes instead of three-dimensionally printed or laser cut materials. Using PVC pipe as our main material has allowed us to build a more cost effective fully functional ROV. PVC pipes are also lighter and reusable, allowing us to easily stay within the weight limit. The PVC pipes we used for our robot were almost entirely reused, and, in addition to helping with cost, this is better for the environment.

Problem Solving

Throughout this school year, we have faced many challenges, the most significant being a time constraint. We did not have as much time to work in person as we had hoped, and this coupled with our team's need to create a brand new robot instead of reusing one from previous years meant that our team had to spend many hours in the classroom from the end of April through the regional competition at the beginning of June.

During the remote part of the school year, our team worked to build individual robots at home, while also expanding our knowledge of programming with Aurduino. This allowed us to show up to our in person meetings with new knowledge on many different aspects of robotics. As each individual student focused on honing different skills, when we arrived back at school, we each had different aspects of Shelby that we worked on perfecting.

Systems Approach

Every component of our ROV system is interconnected and has a purpose that contributes to the functionality of the ROV as a whole. The thrusters that are part of our robot help the ROV maneuver to get closer to a certain object so that the grippers do not have to work very hard to collect objects, so the thrusters and grippers are constantly working together to help the ROV achieve its tasks. The camera aids the grippers and thrusters in being able to carry out its tasks by helping members of the team be able to see where the ROV is going and whether the grippers are close enough to an object to collect it. Even the decorations added to the ROV system help the ROV achieve its goals, by including buoyancy foam that helps keep the ROV neutrally buoyant so every other part of the robot (camera, thrusters, grippers, etc.) can achieve their tasks properly.

Vehicle Structure

Our team has worked very hard to compose Shelby in the most efficient way to combat climate change, specifically pollution. And one of goals is to create a solution to help fix the damage done to the sea. We have many aspects of our ROV system that help us complete our tasks. For example we have the claw, which we had troubleshooting many times. The claw is controlled by our co-pilot. During our limited pool time we had successfully attempted to test Task one which is 1.2 remediation:removing plastic pollution from top to bottom. Specifically removing a ghost net from midwater which is worth 10 points. Also since our 2 claws are not in the same direction, one is horizontal and the other vertically aligned, we are able to have a higher chance of fully completing tasks that involve grabbing things in certain directions. The structure of the camera and its grippers allows for a clear view of what the system was grabbing. All the electrical components are on the outside in the event of a malfunction, any issue can be fixed easier.

Vehicle Systems

This year Subaquatic Solutions chose to include two grippers, one horizontal and one vertical, on the front of Shelby. These grippers were purchased, and then put together by members of the company. We chose to include grippers because we found that they were the most effective way to complete this year's tasks. We encased the control board to the grippers in a jar of blue resin. We chose to use resin because it is cost effective as well as waterproof and easy to use. Attached to the control board in the resin is a CAT-5 cable that runs off Shelby and runs with the other cables back to the control board on our cart. We also included four propellers, two that move Selby up and down, and two that move her left and right. These propellers are covered with shrouds that are 3-D printed.

Control Electrical System

Our ROV system consists of a Sabertooth control box that both powers the video display and controls the tethers, and this control box is connected to the main body of the robot. In the Sabertooth control box, there is a power supply of 12V that runs from a power source and connects to a 15A power distribution fuse. This distribution fuse connects to the two sabertooth controllers that power joysticks that control the robot (one joystick powers the up and down movement of the robot, while the other controls the forward, backward, left and right movements). Cables run from these two joysticks that connect to the four thrusters that help the ROV move. Meanwhile, the video display box has a video cable that runs to the camera, which helps us see out of the ROV. Lastly, the power distribution box also runs to an Acrobatics Manual Dual Servo that has potentiometers which open and close our two grippers. Cables run from the servo through a CAT-6 booster located in resin on the side of the robot, which powers the two grippers.

Propulsion

Originally we intended to use our thrusters from previous years, but we faced many difficulties with them, they would stutter and at points give up. Overtime we decided to replace them and order new thrusters, only for them to work against the shrouds instead of working with the protection provided by the shrouds. Along with our previous intention, we commenced the building of our ROV with shrouds from previous years, eventually 3D printing new ones because of flaws in the others. Our new shrouds had to be sanded because the water being pushed through the shrouds exerted a weak amount of force, slowing down our ROV. We positioned our two thrusters in specific positions in order to ensure that we can move in an efficient manner, two are angled vertically down so that it could go up and down, and two are placed horizontally so that the ROV could go backward and forward.

Buoyancy and Ballast

Testing the buoyancy for Shelby was difficult especially with our limited water source. But when able to test it we were able to figure out that it didn't float on its own, instead it sank to the bottom and touched the floor. We decided to cut up a pool noodle and wrap pieces of it around Shelby with zip ties to help it float on its own. Also we were able to purchase buoyancy foams from blue robotics which we then cut it up and placed around Shelby. Understanding how buoyancy affects the movement of Shelby is very crucial. We figured out how much buoyancy foam we needed based on the multiple tests that we did and where the thrusters should be placed. In doing so we realized that the tether was heavy and not easy to maneuver. As a result we decided to zip tie pool noodles approximately a couple inches apart so it doesn't greatly impact the buoyancy of the ROV. We verified that the camera is moveable, the thrusters are secured at their different angles, and that buoyancy foams are attached around the PVC pipes so our ROV system floats. With the support of the buoyancy foams Shelby was able to be neutral buoyant.

Payload and Tools

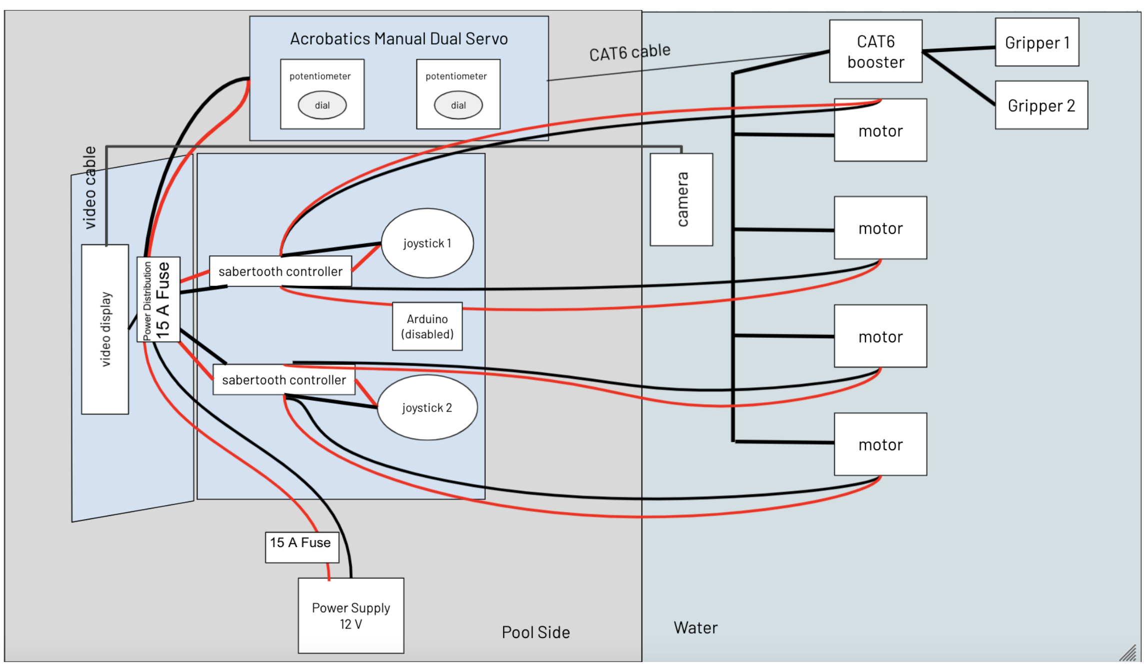
The ultimate goal that our company is working to achieve is to use our functional ROV system to help remove plastic waste and restore both freshwater and marine ecosystems. Our ROV system vehicle consists of a frame with four thrusters, a camera, and two claws, as well as a video display box to be able to see the camera as the robot completed several tasks and an Acrobatics Manual Dual Servo to control the claw of the ROV system.

We organized and designed the order that the tethers would go into the waterproofing tubes to prevent accidental exposure of soldered junctions. Each position of our equipment is symmetrical, aligned, and set in accurate angles after many small adjustments. We verified that the camera is moveable, the thrusters are secured at their different angles, and that buoyancy foams are attached around the PVC pipes so our ROV system floats. Our team decided to add two claws to our ROV system to remove the eel trap, coral fragments, and the old power conductors in the designed area, as well as collecting the samples of sponges and returning them to the surface. Lastly, we decided to use 3D-printed thrusters so there would be exact measurements that we could control so that the movement of the ROV system would not be off, and we did multiple experiments to test out different types of frames, how much buoyancy foam we needed, and where the thrusters should be placed. All of these meticulous details added to our ROV system helped ensure that it would be able to complete tasks at peak performance, and would be able to serve as a model of ways that we can mitigate the amount of plastic in our water and clean our coral and waterways for future generations.)

Build vs Buy, New vs. Reused

Our main purchases while building our robot Shelby were the Triggerfish ROV and Antibiotic Servo Controller. With a limited amount of time, these purchases provided our team more time to build upon what we originally had. We reused many tools as well such as thrusters, waterproof servos, pvc pipes, etc. Our purchases small, and large were essential to building our ROV Shelby. See Appendix A: Cost Accounting, subsection New vs. Reused.

SID



Safety Precautions

In order to ensure that our ROV system qualifies for the MATE international competition, we 3D-printed the thruster shrouds and sanded them with a dremel to avoid the rubbing sound that the thruster made when spinning against the shrouds, assuring they would be able to work as smoothly as possible. Each position of the grippers and other prevalent features of the ROV system are symmetrical, aligned, and set in accurate angles after many small adjustments. After testing to operate our ROV in the swimming pool, we found out that we needed to drill multiple holes on the PVC pipes to enable the air bubbles to escape and made it easier for the ROV to drown down to the bottom of the pool. Our team also applied 2 15amps fuses to connect the proper electricity for the thrusters to operate at its peak performance. Troubleshooting problems that arose during the team meeting were also an important stage of our manufacturing. Our team made sure that all tethers and any electricity-related materials followed the safety protocols and were completely covered with waterproofing tubes. We organized and designed the order that the tethers would go into the waterproofing tubes to prevent accidental exposure of soldered junctions. Then, we used heat guns to shrink the tubes and applied glue guns to fill in any uncovered spaces. Additionally, our team recorded the mass of each thruster, claws, waterproofing tether bottles and determined the precise positions of each piece to balance the ROV. All of these meticulous details added to our ROV helped ensure that it would be able to complete tasks at peak performance, and would be able to serve as a model of ways that we can mitigate the amount of plastic in our water and clean our coral and waterways for future generations.

Testing and Troubleshooting

Throughout this year, Subaquatic Solutions produced Shelby, and while we built the ROV system, precautions were taken and planning was made. The planning consisted of how to successfully complete tasks, but also how to solve any issues that could arise. When an issue did appear during our practice periods, our group was quick with responding and planning solutions. As such, Subaquatic Solutions tried to make every step and detail of our system functional. Therefore, every part of our ROV system, Shelby, was premeditated or had a reason behind it.

A part of Shelby which was heavily thought upon were the two grippers. At first, both grippers were positioned horizontally. An issue that we thought of was that the gripper could malfunction or lose power, therefore one of the grippers was positioned vertically, where if the gripper did lose power, it could still be used as a hook. Another problem that arose with having horizontal grippers would be that horizontal poles are held better by a vertical gripper. At the same time, a horizontal gripper better helps with a vertical pole or tube.

The frame of our ROV system was also very thought about. As we tried to include the camera in the middle of a system, such a design was created. Adding on to the camera, we intended to have both of our grippers in the ROV's sight and not in any blindspot, allowing for the driver to have better control. As you can see, the purpose of such a frame is to have all of the components relatively in the middle, the thrusters and their shrouds are closer to the center of the system, as well as the buoyancy centered. To be very effective, a smaller frame would allow for slightly quicker speed, as least weight is being pushed. The smaller frame also allows for the electrical components to be outside of the frame and can therefore receive repairs.

Accounting

Budget

The purchases for the ROV Team came out of the robotics budget. We've spent our budget on buying essential things to build shelby. We've purchased video cameras to see through shelby's eyes, servo controllers, cables, and other essential things. Without being wasteful, we reused parts from our old ROV that was made in 2019. PVC pipes, PVC cutters, pool noodles, buoyancy foam, soldering tools, etc., were just some of the tools we reused while building Shelby.

Cost accounting

We've spent a total of $1849.50 on our supplies to build Shelby. See Appendix A: Cost Accounting

Appendix A: Cost Accounting

Item name	Costs
Triggerfish ROV with Thrusters and Tether	725.00
10 Pieces T-handle Hex Key Set T-key Allen Wrench Kit	16.99
Actobotics® Servo Controller (x2)	159.98
6" Male to Male Extension (x2)	7.98
D646WP Servo-Clockwise	54.99
Standard Gripper Kit A (x3)	29.97
Cost-Effective 1080p Hd Industrial Usb2.0 Camera USB Camera Module	50.99
25.0' CAT6 Cable	9.99
Actobotics® Hardware Pack A	39.99

ATC Blade Type Fuses (Amps: 15) Pack of 3 (x10)	9.90
ATC Style Fuse Holders with Powerpole Connectors (x3)	47.97
2.1mm x 5.5mm DC Male Power Plug to Anderson Powerpole Adapter 6 Feet (x4)	31.96
Four Thruster Kit	132.00
Pufferfish Video System Kit - TWO Cameras	180.00
Tie-Dye Team T-shirt	351.79
Total Cost	**1849.5**

New vs. Reused

Item name	Re-used/ Purchased
PVC pipes	Re-Used
PVC Cutter	Re-Used
Pool Noodles	Re-Used
Buoyancy Foam	Re-Used
Digital Multimeter	Re-Used
Cable Zip Ties	Re-Used
Tape Measure	Re-Used
KOTTO Third Hand Soldering Tool	Re-Used
Soldering iron	Re-Used
Wire Stripper	Re-Used
Rotary Tool	Re-Used
Silicone waterproof glue	Re-Used

m10 cable penetrator	Had extra