HYDRO CUSTOM PREFORMANCE

John Hancock College Prep • Chicago, Illinios • The Hancock Aquatic Eagles

Team members from left to right: Jesus Caballero (Technician/Co-Pilot, graduates June 2, 2014 and plans to major in Engineering), Irving Alamilla (Technician/Electrical Engineer, graduates June 2, 2014 and plans to major in Biology), Carlos Barrios (Technician/CFO, incoming senior, plans to major in Aero Space Engineering), Marisol Ramirez (Public Relations Manager/Technician, graduates June 2, 2014 and plans to major in Accounting), Vincent Calderon (CEO/Technician, graduates June 2, 2014 and plans to major in Computer Science), Jennifer Mondragon (Technician, Pool Professional, incoming senior, plans to major in the Performing Arts), Ivan Lopez (Technician/ Pilot, incoming senior, plans to major in Computer Engineering)

Mentor/Instructor: Jennifer Stites

Abstract

Hydro Custom Performance is on the southwest side of Chicago, situated at John Hancock College Prep High School. We are a new company and are proud to be a part of shipwreck investigation and recovery operations. We have designed our underwater ROV, the Aquatic Eagle, to be able to accomplish the required tasks for this mission. This is designed to be a low-cost option for shipwreck and science investigations, as well as for conservation efforts. If this ROV were to become tangled in a shipwreck or lost in the lake, it would not be expensive to replace it. We made a prototype model with K'nex to test out our design before construction. The ROV is equipped with a camera to allow the operators to view what the shipwreck looks like and gives them the ability to maneuver the ROV efficiently. The ROV also has four motors to provide propulsion in all directions, and which have the ability to be controlled individually to maximize mobility. In addition, the Aquatic Eagle is outfitted with two hooks to allow it to manipulate objects in the lake and inside shipwrecks to further allow exploration. Finally, our ROV has been equipped with flotation devices on its frame and on its tether in order to enhance buoyancy.

Table of Contents

Safety

We wore goggles to protect our eyes while using the power tools. We used gloves when needed. We were careful with the electricity and made sure to waterproof the wires and we tested this by dropping into a bucket of water the part of the wires where the waterproofed connections were between the motors and the tether. In addition, we installed two 15 amp fuses, one to the camera and one to the control box, for protection.

When operating our ROV, we followed a safety checklist, outlined below.

We made sure that:

All electrical connections and safety features were included in our schematic.

All wires, flotation, and other attachments were securely attached.

The propellers were angled so that the blades were inside the frame.

No sharp edges or points protruded from the ROV.

There was a single attachment to the 12 V battery.

There was a 15 amp fuse between the battery and the control box.

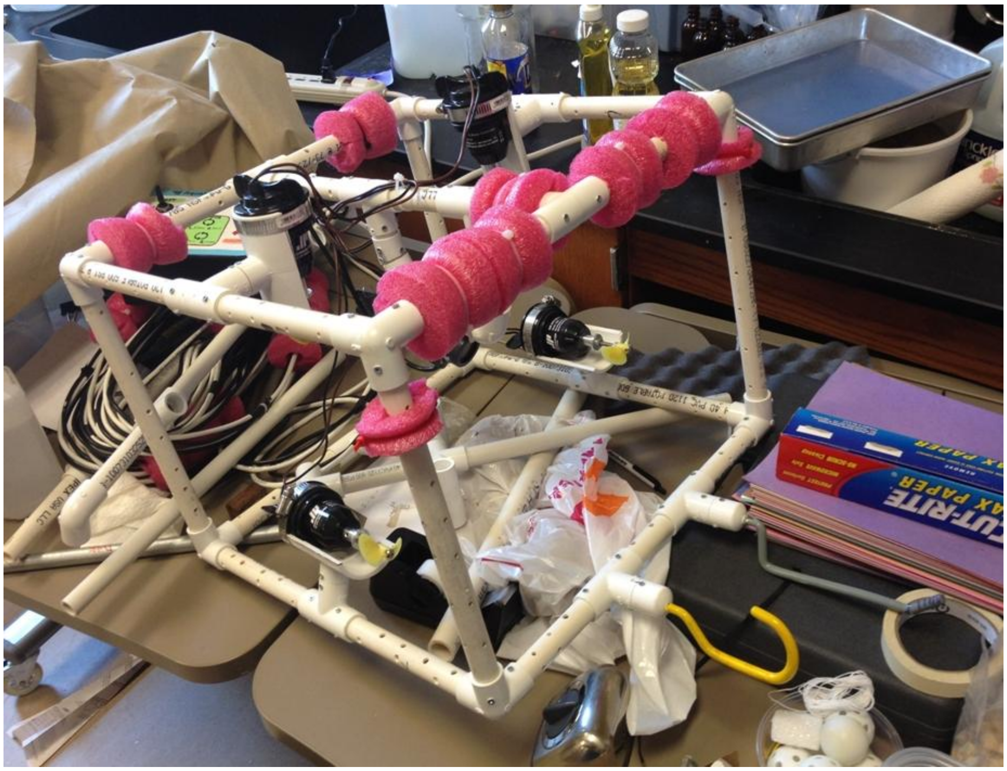
There was a 15 amp fuse between the battery and the camera.

There were no exposed wires at any point.

All of the wiring was securely fastened and waterproofed or sealed.

The tether was properly connected and managed.

The Aquatic Eagle ROV



The Aquatic Eagle ROV, pictured above, features a sturdy and lightweight pvc frame reinforced with screws, four motors, an underwater fishing camera, two hooks, and pool flotation tubing for buoyancy.

Theme

Remote Operated Vehicles (ROVs) are instrumental in completing many tasks that would otherwise be difficult. The purpose of this mission is to design a ROV that is able to perform several tasks in the Thunder Bay National Marine Sanctuary (TBNMS) in Lake Huron.

One task involves investigating shipwrecks. Humans have used ships on the ocean and in lakes for many years. Sometimes they are caught in storms or are attacked and they sink. These are called shipwrecks. Researchers and explorers have searched for and studied shipwrecks. Modern technologies, such as underwater ROVs, have made this more possible. There are several shipwrecks in Lake Huron that are found near the Thunder Bay National Marine Sanctuary.

Another task involves scientific investigations. The TBNMS has many interesting scientific features. There are sinkholes that have a high salt concentration due to groundwater carrying minerals seeping up. This affects the conductivity of the water. Conductivity meters are used to test this. Microbial mats of bacteria grow near these sinkholes and are interesting to study. ROVs can grab samples of these for study.

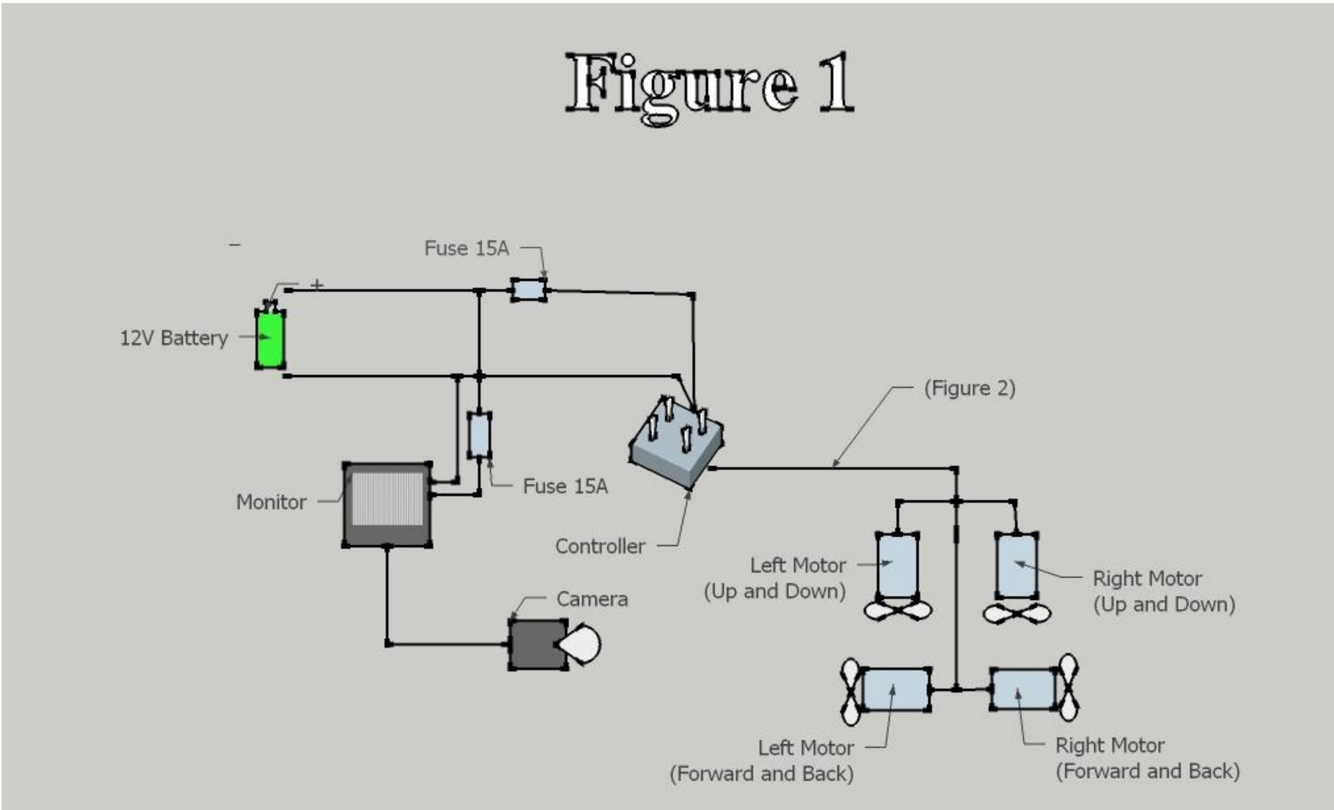
Lastly, conservation is an important task. ROVs can be used to assess pollution and to clean up garbage at the bottom of the lake.

Design Rationale

Being our first year we went with a simple frame design compromised of screws and PVC pipes.

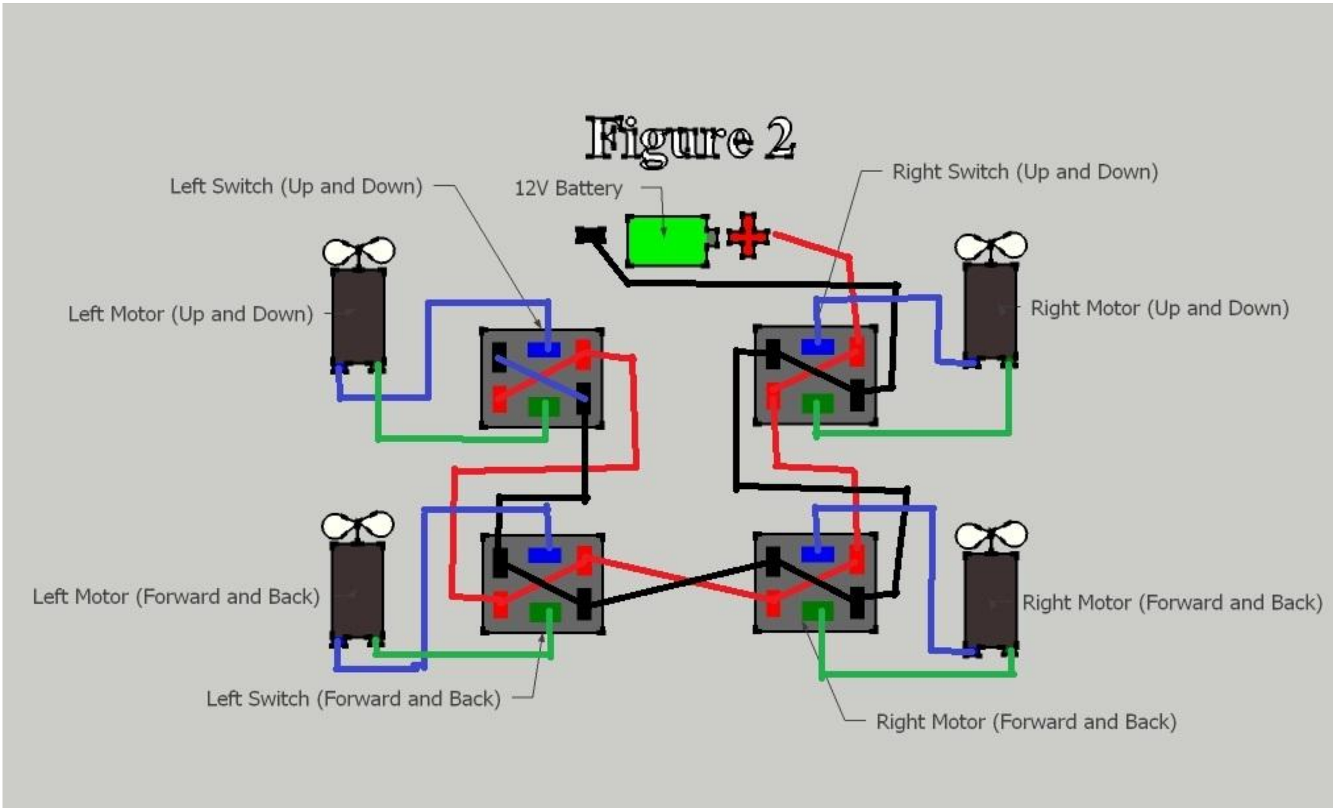
Our ROV is made of ½-inch pvc tubing. The connectors are screwed onto the tubes. It is rectangular, 36 cm tall, 44 cm in length, and 44 cm wide. It has four motors with propellers. Two of the motors are angled to give forward and backward motion, and two are angled to give up and down motion. The motors are connected to the frame with hose clamps. Buoyancy is provided by using pool floaties. Two enamel-coated hooks, are attached to the lower front pvc tube. They are screwed into the end caps. The hooks are for completing the shipwreck mission. They will be used to open the cargo container, move the sensor strings, the anchor line rope and the quadrat. An underwater fishing camera is attached angled towards the front of the ROV pointed down at about a 45 degree angle. This will allow us to see the shipwreck parts so that we can pick them up. The motor wires are connected to the tether wires with solder. Hot glue and shrink wrap was applied in order to water-proof them. The tether wires are connected to the control box, and power is supplied by a 12 Volt battery. Two safety fuses are included in the wires from the power supply to the control box and to the camera.

Schematics



Systems Integration Diagram

Created by Ivan Lopez (company staff)



Control Box Wiring Schematic

Created by Ivan Lopez (company staff)

Budget Expenses

Item(s) (most donated through program from Shedd Aquarium)	Estimated Cost ($)
Frame	
½ inch pvc tubing and connectors	40
Machine screws, 5 boxes	5
Swim noodle	3
Assorted electrical parts, wiring, fasteners	80
Propulsion	
Waterproof bilge motors, 4	112
Propellers, 4	12
Propeller adapters, 4	20
Optics	
Underwater fishing camera with monitor	80
Payload	
Hooks, 2	12
Total:	369

Challenges Faced

The buoyancy gave us trouble with trying to figure out how much to add and take off because if we had too much the rover would not sink and mobility was highly affected. If there was too little then it was very difficult to get the rover to return to the surface.

We started with one hook to try and lift objects out of the water. We started with only one because we were really going into this competition blindly with it being our first year. We were not able to manipulate objects underwater very well. Therefore we later added a second hook, which improved the ROV's ability to perform the tasks.

Lessons Learned

One thing that we learned was how our frame of the rover affected the weight of the objects we were trying to move out of the water along with its buoyancy. The buoyancy affects the angle that the rover moves through the water when it is pulling an object out of the water.

Future Improvements

The rover would be improved through testing of a smaller frame to limit drag, positioning the engines at the bottom of the frame to give the best amount of power from the motors and not having them exert extra power, and possibly adding a retractable claw to help grab and control the objects in the water.

Reflection

For this being our first year we found that we were very successful, we managed to make it to internationals which we did not expect. Our team work is what really got us this far, we dedicated a lot of time and energy on this endeavor and we couldn’t be more pleased with its outcome.

Acknowledgements

This project is generously supported by the John G Shedd Aquarium in Chicago. In addition, this program was supported by Motorola Solutions. Finally, we would also like to thank the Marine Advanced Technology Education (MATE) Center for their support of ROV education and the tutorials on the website. We would also like to thank Ms. Stites, our science teacher and mentor for this project.