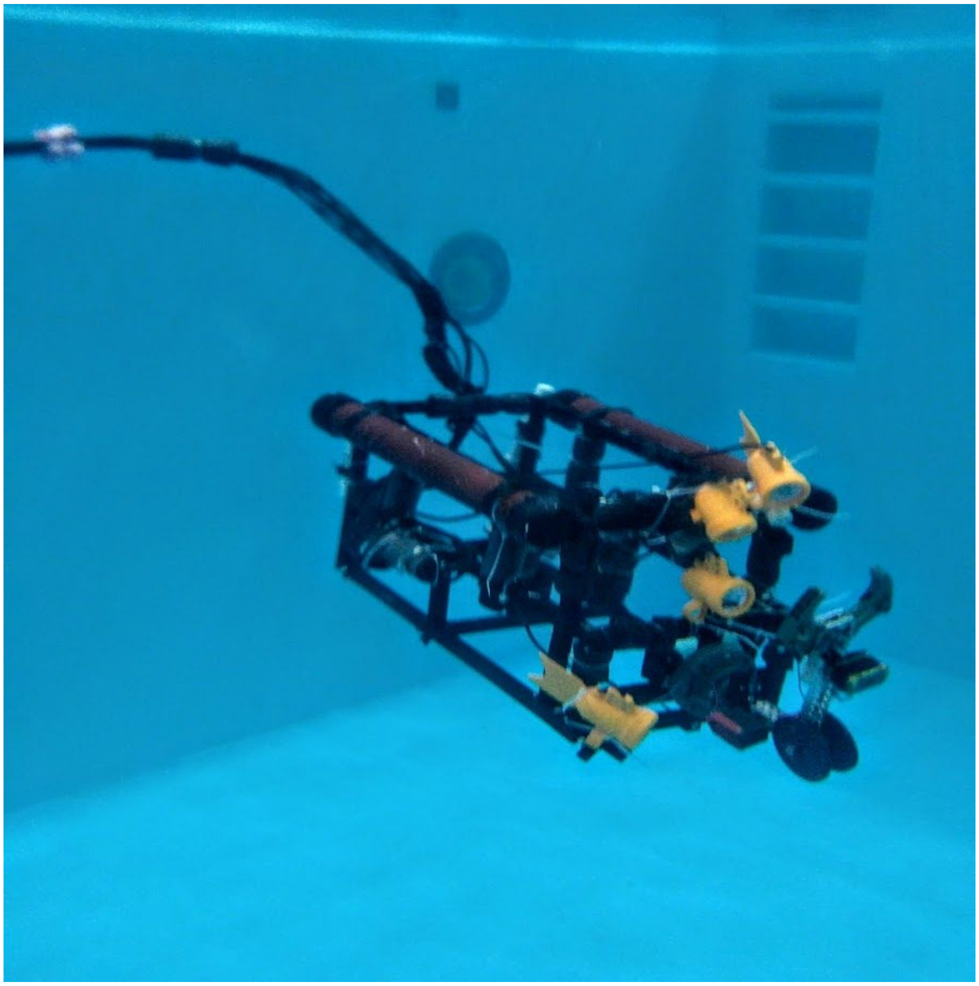
ROVO



Melvindale high School

Melvindale, MI

Mate 2016

Company Members

Riyon Affara-CEO

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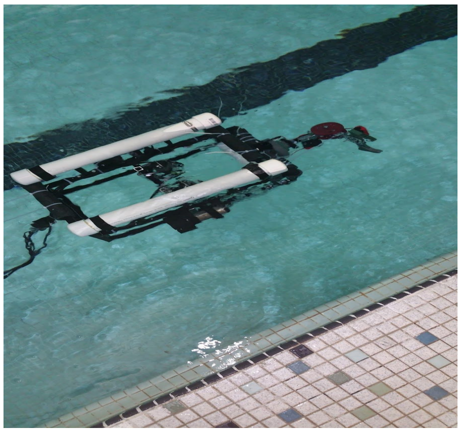
Mentor- Randy Thomas

<u>Table of Contents</u>

Abstract

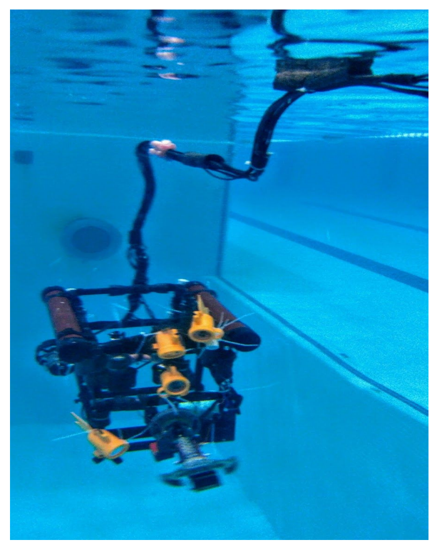
Aqua Cards Inc. has constructed high-quality underwater remotely operated vehicles for the past 4 years designed specifically to complete all the clients

Figure 2.2



missions efficiently and effectively. ROVO our most advanced R.O.V. up to date has been distinctly designed to not only survive the trip to Europe, but to also operate efficiently in the harsh condition of both deep ocean and outer space. Operating effectively in the deep ocean is vital in being able to find and recover critical equipment that fell into the Gulf of Mexico, collect and analyze data from oil mats located in the northern Gulf of Mexico to determine their origin, photograph and collect samples of deepwater corals, and lastly prepare a well head for decommission and conversion into an artificial reef. ROVO is equipped with cutting edge technology such as a dynamic calw, state of the art underwater cameras, stupendous thrusters, cutting edge monitors that enable sensational display. Such advanced technology allows ROVO all mission specifications. Allowing us to keep our respective level of making distinguished rovs at Aqua Cards Inc.

Figure 2.1



Safety

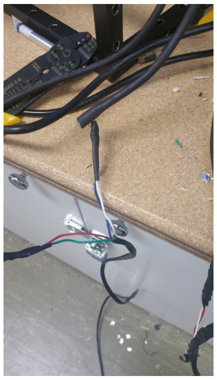


Figure 3.1

The safety features for The ROVO, have been put in to ensure that hazardous incidents do not occur. The four motors run at 2500 rpm. To make sure no fingers get sliced off, we have motor guards and a caution sticker as seen in figure 3.1 & 3.2.

Figure 3.4

Every one of our wires is soldered, shrink-wrapped, and taped, to ensure maximum protection from electrocution. And short-circuiting. The two Servo motors for our claw are glued and taped all around to waterproof them. To keep from tripping people with the tether wires, we zip-tied all of the wires every 18 centimeters. During construction of the R.O.V, all of our team members always wear goggles(figure 3.3). Goggles help to prevent any shrapnel from entering our eyes. We also have a 25 amp fuse to prevent overheating and fires. Stopping an overload is very important when dealing with a wired vehicle. Our wooden controller box is also safe. We added a lexan cover to prevent water from getting into the motor and claw box. We did all of these precautions to ensure our R.O.V is the safest, and for the safety of our team members. Safety is always our number one concern through the whole process of assemble our R.O.V as well as when we are demonstrating our R.O.V. AquaCards strive to provide our customers with the safest possible R.O.V available.

Figure 3.2

Figure 3.3

Finances

	Balance	
Materials	***Starting Balance:*** $6,200	**Cost $$$**
¾" Black Al.	$6,136	$64.00
Crimps	$6,127	$8.99
PVC Piping	$6,112.51	$14.50
Wiring	$5,988.51	$124.00
Control Box	$5,978.52	$9.99
Screws	$5,970.53	$7.99
Fuse Holder	$5,967.04	$ 3.49
Cameras	$5,179.04	$197.00 ea. (4)
DVD Players	$4,663.04	$129.00 ea. (4)
Motors	$3,663.04	$250.00 ea. (4)
Servos	$3,617.04	$46.00 ea.
Claw parts	$3,558.04	$59.00
Plastic Joints	$3,423.40	$135.00
Noodles	$3,408.45	$14.95
Mission Props	$3,213.33	$195.12
End Balance/Total:	$3,213.33	$2,986.67

Design Rationale

Many things have been done to our R.O.V design for specific reasons. The design is fully based around the versatility and durability that we have found to be essential in the overall operation of a ROV. We moved away from the flimsy and easily damageable PVC piping that we used to make the frames of our previous ROVs. Instead we used much sturdier and more reliable square black aluminum tubing. This aluminum tubing offered much more strength to the ROV without adding extra weight, cost or difficulty in the construction with our limited supply of machinery. The black aluminum is also naturally resistant to corrosion and is safe for use in underwater applications. We used Esto connectors, which were screwed into through the frame to offer a sturdy hold between each of the pieces. This allowed for the frame to be both adjustable if needed and completely sturdy. The shape of the ROV is meant to offer versatility in any application for which we use it. The basic rectangle design leaves a lot of open space both inside the frame and on the outside for future attachments. This versatility has proven to be exceedingly vital in many of our previous designs as well as in The ROVO. On many occasions we have faced a situation in which a quick attachment was needed to complete a mission. The versatile shape of the ROV has allowed for these quick fixes, which would be much harder to do on complex systems. The cross bars in the middle of the design offer both support and attach points for the thrusters of the ROV. Our framework is one of the best examples of versatility and durability coming together in the ROVO.

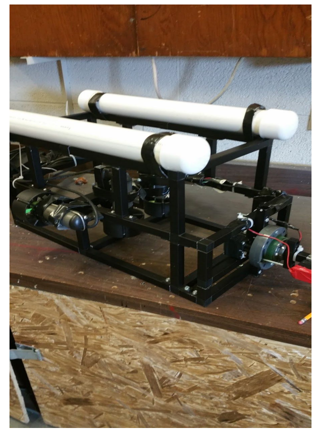
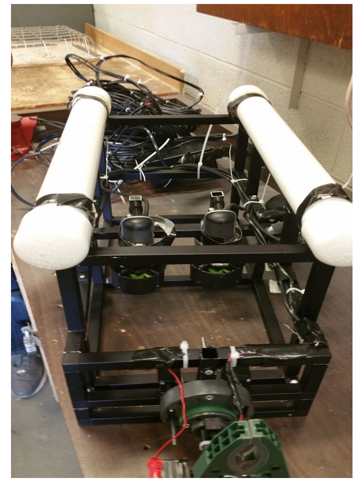


Figure 5.1

Figure 5.2

Buoyancy

Figure 6.1



Two sealed PVC tubes offer all of the buoyancy control for ROVO The two tubes are cut to specific lengths to offer the correct volume of air that allows the design to remain almost completely neutrally buoyant underwater. We had to add a 3 pound weight at the back of the R.O.V to level it. This relatively neutral buoyancy allows for easy navigation of the ROV. The tubes are sealed with PVC cement and do not allow any leaking into the tanks that would throw off the overall buoyancy. Each tank is placed in a specific location to remain out of the flow created by the thrusters. In early designs tubes were getting in the way of the propulsion and lowering performance. The current positioning allows for the thrusters to remain uninterrupted and the buoyancy tubes to still work effectively. We also have floating tubes for our tether to have it reduce the drag of the rov.

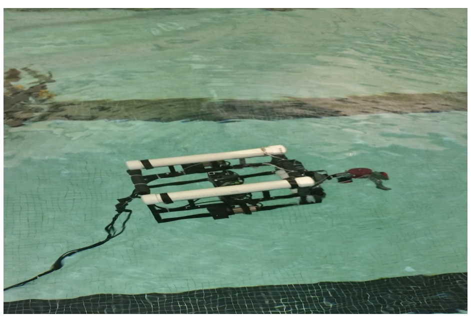


Figure 6.2

Figure 6.3

Mission I:Outer Space Mission to Europa (100 points)

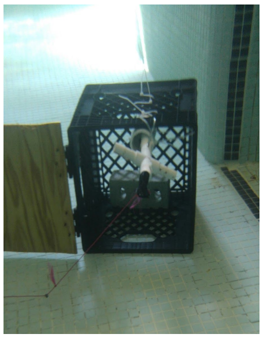


Figure 7.1

In the real world, there are oceans in space. Europa, one of many of Jupiter's moons, is one of those places. This mission would be very necessary in the real world so that scientists can see how thick the moon's ice is, and to see the depth of the icy waters. Our company is using a measuring tape to calculate the exact depth and thickness of the ice and the water. Also we need to find out the temperature of the water jetting from the crevice. In space the the temperature would be frigid. We are using a thermostat probe for that part.

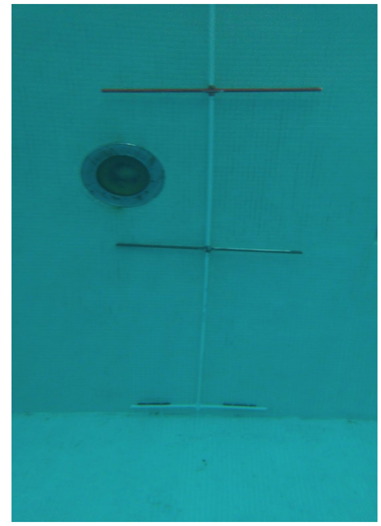


Figure 7.3

Mission II: Inner Space Mission-Critical Equipment Recovery (40 Points)

CubeSats, which are miniaturized satellites for space research, are very useful for aerospace and nautical research. In this mission, four are needed to be retrieved in the Gulf of Mexico for research. Our company will survey the seafloor to identify and retrieve the specified CubeSats and place them in the recovery baskets/net to be retrieved by a crane at the surface.

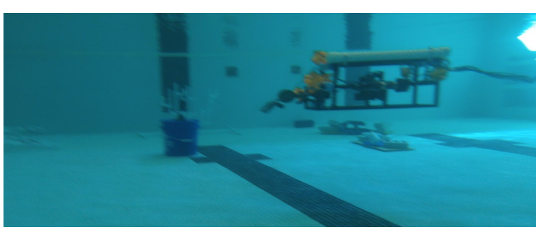


Figure 7.3

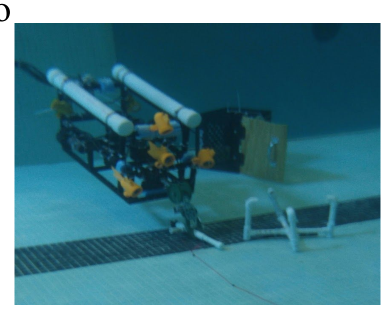


Figure 7.4

Mission III: InnerSpace Forensics Fingerprint

(40 Points)

In the real world oil spills do occur sadly. For example, the most famous BP Deep Sea Horizon oil rig, 6 years ago. When oil samples are found on the seafloor, the sample is captured and analyzed its gas chromatograph. A forensics team will analyze it to see where the oil originated from. Our company will retrieve a sample from the locations and it will get analyzed on land. Then the samples will be matched with other oil fingerprints to determine the origin.

Figure 8.1

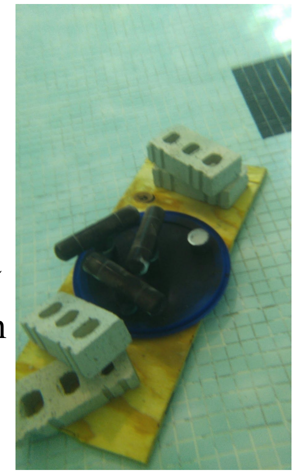


Figure 8.2

Mission IV: InnerSpace Deepwater Coral Study (30 Points)

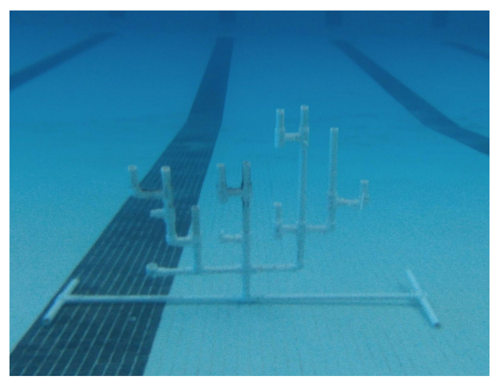
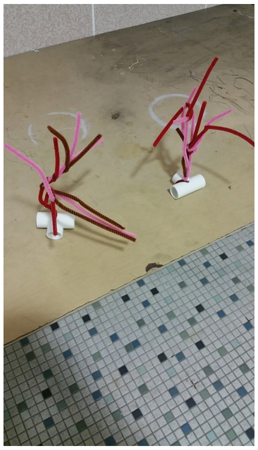


Figure 8.3

This missions occurs very often in the real world by R.O.Vs and even scuba divers. The corals all over the world need to monitored for endangerment and to protect the health of the most important ecosystem in the world. After an oil spill all the wildlife and coral are in immediate threat of dying from the oil. In this mission our   company will analyze the current coral in the Gulf with preexisting photos of the coral before the spill occurred. We will determine whether the corals have grown, decreased, or stabilized in size.

Mission V: Inner Space Rigs To Reefs (50 Points)



For this mission our company has the task of converting an oil wellhead into an artificial reef. This task occurs often in the real world, during the BP oil spill, R.O.Vs saved the day by capping, bolting, welding, and screwing the valves and caps as seen in We designed our claw with this mission in mind.Since our claw has the ability to not only go up and down but also rotate 360° will should have no problem with the tasks need to successfully convert the wellhead into an artificial reef. By successfully converting the wellhead into an artificial reef we can help the ocean life.

Figure 9.1

Figure 9.2

Figure 9.3

Figure 9.2

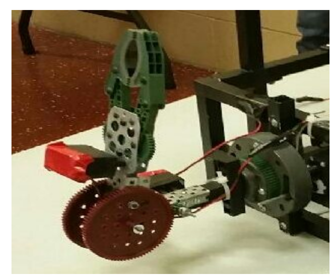
Control System

Figure 10.1

Figure 10.2

For our control system we used two black plastic boxes; one for our motors and one for our claw. We used four momentary DPDT switches to control all navigational aspects of the ROV. For the claw we used four of the same switches to control the opening and closing of the claw as well as the vertical motion of the wrist.The other two were to rotate the claw 360° .These boxes are encased in a larger box to keep them organized. Each switch is also labeled so that, in case of emergency, any one member of the team could easily take over maneuvering the ROV. This box allows for very simple, yet accurate controlling mechanism for the operation of the ROVO

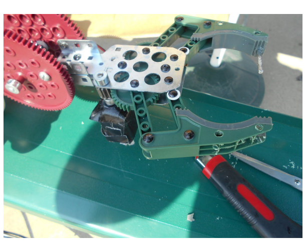
Figure 10.3



Claw

When designing our claw, we considered the tasks the claw needed to accomplish and the qualities necessary to accomplish them. Our finished claw provides a mechanism for transportation, placement and removal of various objects in a wide range of size and weight. It also controls many of the attachments used for the mission such as turning valves to turn off water pressure and grabbing caps. It is a simple open/close claw that grasps mostly all objects. We wanted to mechanically advance our claw. To do this we thought of a two gear rotating system to allow our claw to rotate freely left & right 360°.We got halfway through building the prototype then found the exact piece we were looking for online. That is the part we are using today. This special part is like a turntable. It is two gears on top of each other with two motors on the side rotating them clockwise and counterclockwise.

Figure 10.4



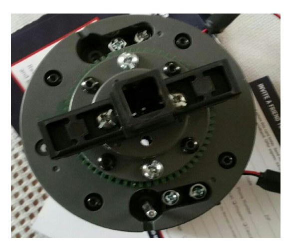


Figure 10.5

Motors

Since discovering the SeaBotix BTD150 thrusters in 2014, the AquaCards have never wavered from their use. The BTD-150s provide a powerful thrust capacity while remaining relatively lightweight and small in size. Each thruster is capable of a maximum output of approximately 28.4 N, with an average continual output around 21.6 N. This force comes from a thruster that is only 17 cm long with a weight of 350 grams underwater. ROVO is equipped with four of these durable and well-suited thrusters; two for vertical adjustment and two for propulsion and control. The positioning of the thrusters is designed to offer the highest performance as well as the most efficient output when working together. By placing the vertical thrusters equidistant to each other and in the center of the ROV, the vertical motion of the ROV is ensured to more smoothly up and down without any swaying or rocking to throw off the precision needed to complete the missions. The propulsion thrusters are also placed in the center of the ROV in regards to both height and length. Placing them in the center of the length of the ROV is another way to keep it from rocking or swaying when moving. Keeping them in the center of the height allows the move forward and backward without additional vertical motion other than that controlled by the vertical thrusters themselves. This specific placement of the thrusters makes sure that the only movement of ROVO comes from the manipulation of our pilot.

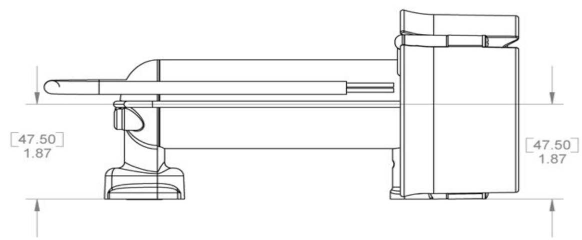


Figure 11.1

Circuits

Figure 12.1

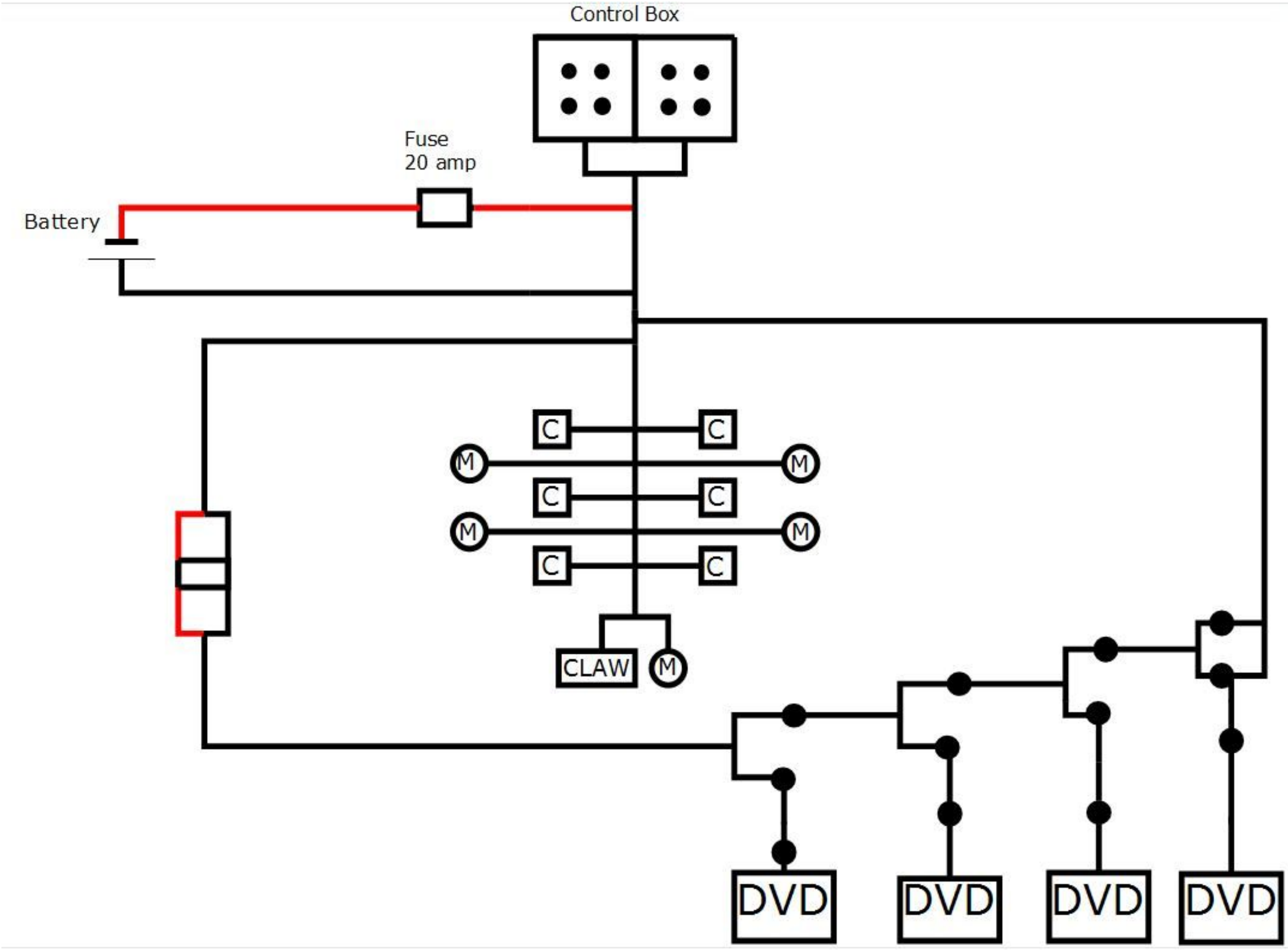
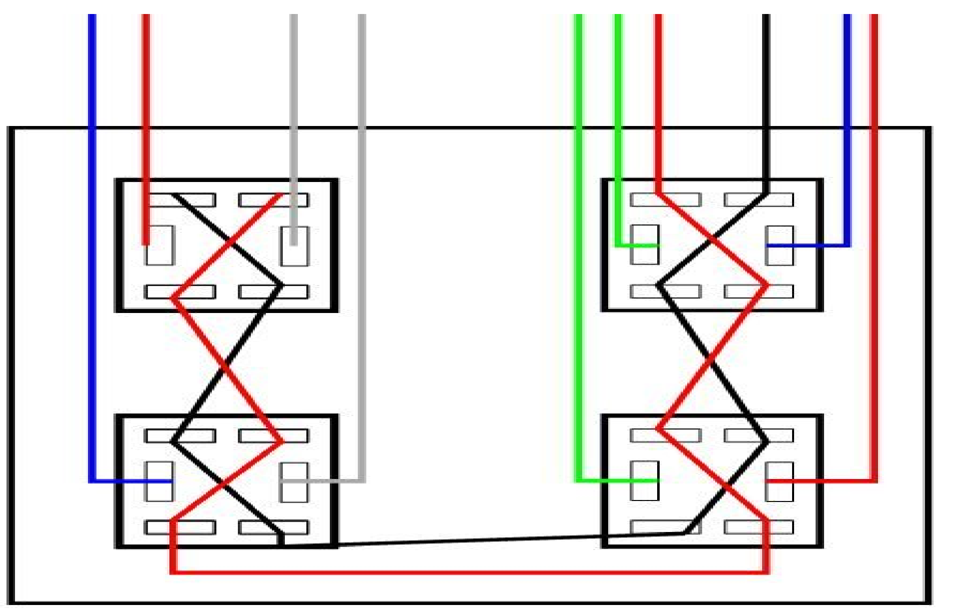


Figure 12.2

Controller Box Wiring



<u>Lessons Learned</u>

This year while building our R.O.V, our group has grown and learned a multitude of lessons. For example, most of the team is in their second year. A lesson learned from last year is that we should start earlier in the school year to finish on time , and not be rushing towards the deadline. This year we started in the summer so we could get a nice head start. Only one of our group members used to be able to solder, now it is up to 4 people. We learned how to shrink wrap our controller box wires instead of duct taping them. This made the process so much easier. Last year it took us 1 week to finish our wiring,as opposed to 4 hours!!! We learned that the less wires the better. Previously, we had up to 8 bulky wires on our tether, this year we lessened it. Our main box which held all of our control boxes took 1 full day to make it. After becoming more efficient it only took 2 hours!!! We started to master a lot of things after much repetition. We wanted to start sharing the lessons we learned. After learning so much this year, we started helping other teams finish their ROVs. We helped teams waterproof everything, solder their wires, crimp, and cut PVC. The lessons we learned everyday are what shaped us into being the team we are today.We like to teach each other so we can all learn, work and grow together as one team. The most important lesson is to not argue. *'A house divided will never stand"* - *Abraham Lincoln.* We rarely argue with each other. We realized we will never get anywhere if we did. We have seen teams fall apart like that before. And Finally, the last lesson we learned was to have fun!!! What is the whole point of competing, building, and growing with your friends if you cannot have fun.

Future Improvements

One area where our team would like to improve on for next year is the control system. These past two years we used a simple simple box control with momentary DPDT switches. We would like to incorporate a joystick for our control next year or use a xbox/playstation controller(figure 14.1 & 14.2), or maybe even a joystick. With a new control system, also our R.O.V would be so much easier to operate. Next year we want our claw to not only 360°, but also move on a Z axis, giving the pilot a fully functional robotic arm. Since this year we focused so much on creating a 360°, claw we did not get the chance to focus on our control system. Another area where we would like to improve on for next year would be our monitors. We currently use portable dvd players for our display system. Each time we use the ROVO, we use 3-4 monitors. We constantly have to keep charging them because they do not have a long battery life.. We would like to use a laptop or tablet(figure 14.3) and split the screen into 4 to display the 4 camera views. With the new screens the quality of viewing would be so much better. It would also help the piloting of the R.O.V the pilot would be able to look at multiple screens. In the end, these improvements would allow for easier transportation and smoother operation of the R.O.V.

Figure 14.1

Figure 14.2

Figure 14.3

Figure 14.3

Challenges

Just like in years past our R.O.V team faced challenges. This year our group faced minor challenges that did give us some trouble. Maybe one of the most common problems we encountered in making our ROV was inaccurate measurements in cutting aluminum bars to build our frame. This did slow our process down somewhat but with time and patience we did get our frame finished with no errors. Another problem our group faced was dealing with loose wires that were connected to our switches in our control box. With this we had to replace many crimps in our control box that were loose in holding the wires in place. What had to be the biggest problem for our group in making our ROV was waterproofing our servos for our claw. First, while looking at the servos an opening along the sides could be seen. We looked at it like it was nothing important to deal with in keeping air tight. We just rolled on some gorilla tape along the side feeling confident it would seal out water. We learned the hard way that we were wrong. Our first time in putting our ROV in the water everything was running smoothly until we attempted to use the claw and it did not work. After knowing our claw was not working, we pulled our ROV out the water and we tried using our claw again but it still did not work. We then took off the servos and noticed the water was coming out from beneath the gorilla tape we had wrapped around it. Knowing our mistake, we had to replace our current servos but we were wiser and we added some super glue along the openings to make a complete waterproof seal. The method worked flawlessly. It has provided a watertight seal to the system, which has now completed over thirty dives without any signs of water damage or failure. a big problem we had was making our claw rotate 180°-360°. At first we built a prototype, weeks later we found a part for that online. Thankfully, we overcame our challenges and completed the building of our R.O.V unit, (ROVO)

Figure 15.1

Cameras

The optical system onboard ROVO is composed of 4 color cameras. The cameras are all on the front of the ROV and offer a wide variety of viewpoints for the pilot. The main forward camera offers a general driving view for basic maneuvering and control. The camera located on the top right hand corner offers a view of the claw from above. This camera is vital to completing missions in which object must be removed from the pool. The third camera located on the left side of ROVO offers an angled view of our claw. Our Fourth camera, is located on the bottom right side of ROVO, offers us a view of the objects located on the seafloor. Our 5th camera which is not stationary is only attached when we are measuring objects. We also have back-ups aboard ROVO incase we encounter a problem with one of our cameras.We made sure that ROVO is prepared in a variety of situations that could cause major problems with important systems onboard.

With the optical system that we have set up, we should get a clear view of the mission at hand and have a fairly easy time completing the missions.

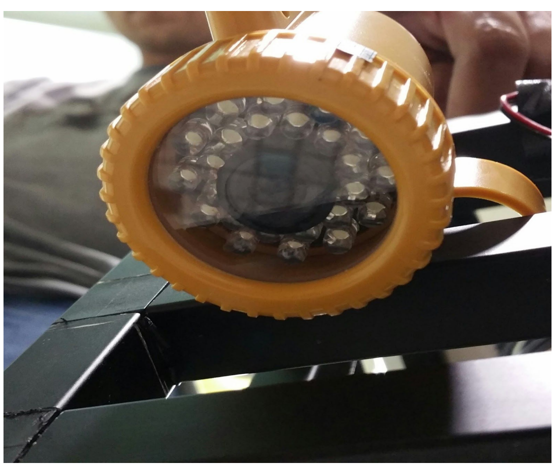


Figure 16.1

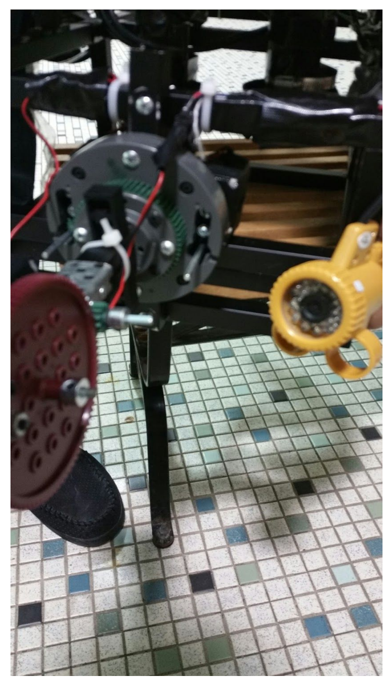


Figure 16.2

Reflection

The MATE ROV competition is an excellent example of STEM education in action. The tasks of the mission theme has pushed us into thinking outside of the box. This year's missions showed us real world examples of what commercial R.O.Vs do on a daily bases like oil rigs, and glaciers. This competition helped us realize the career path we want. I am extremely interested in this field and plan to pursue it in the future. During the process of building our R.O.V we learned a lot of information that will follow us throughout our careers. We feel that what we learned this year will help us unbelievably in our futures. The Mate R.O.V competition has provided us with experiences that we will never forget and have created new friends throughout this whole experience. These experiences could not be learned in a regular classroom.

Acknowledgement

We will now like to take some time to acknowledge some of the people who helped us during this ROV experience. Seitz Middle Schools for allowing us to use their pool, Melvindale High School for supporting us, Mr. Thomas for mentoring us, and all the parents who have supported us. In addition to those, we would also like to thank our donors who provided us with the equipment we needed. Melvindale Teachers, Melvindale Hardware, and Square One. To these people we generously thank. We could not have done it without them. To the MATE Center we would like to our gratitude to you for providing us with this great opportunity. MATE Center makes dreams come true. Thank you to all of you.

References

VEX
ROBOTICS DESIGN SYSTEM

SQUARE ONE
EDUCATION NETWORK
the future starts with us

MELVINDALE
M
PUBLIC SCHOOLS
NORTHERN ALLEN PARK

MATE