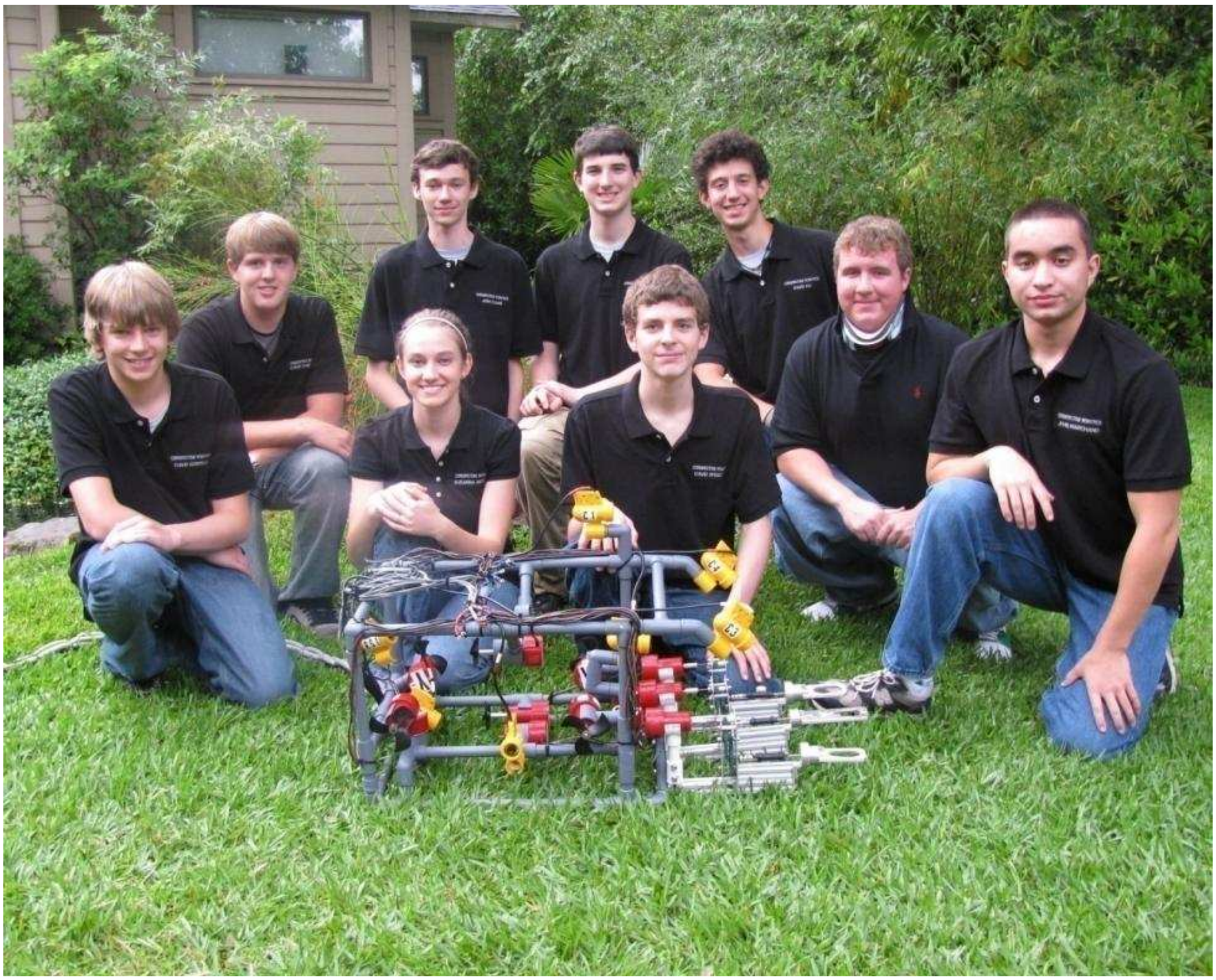
2009 MATE ROV International Ranger Class Competition

Cornerstone Academy Robotics

Technical Report



ROV: Peg-Leg

Team Members:
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Jeffrey Knack

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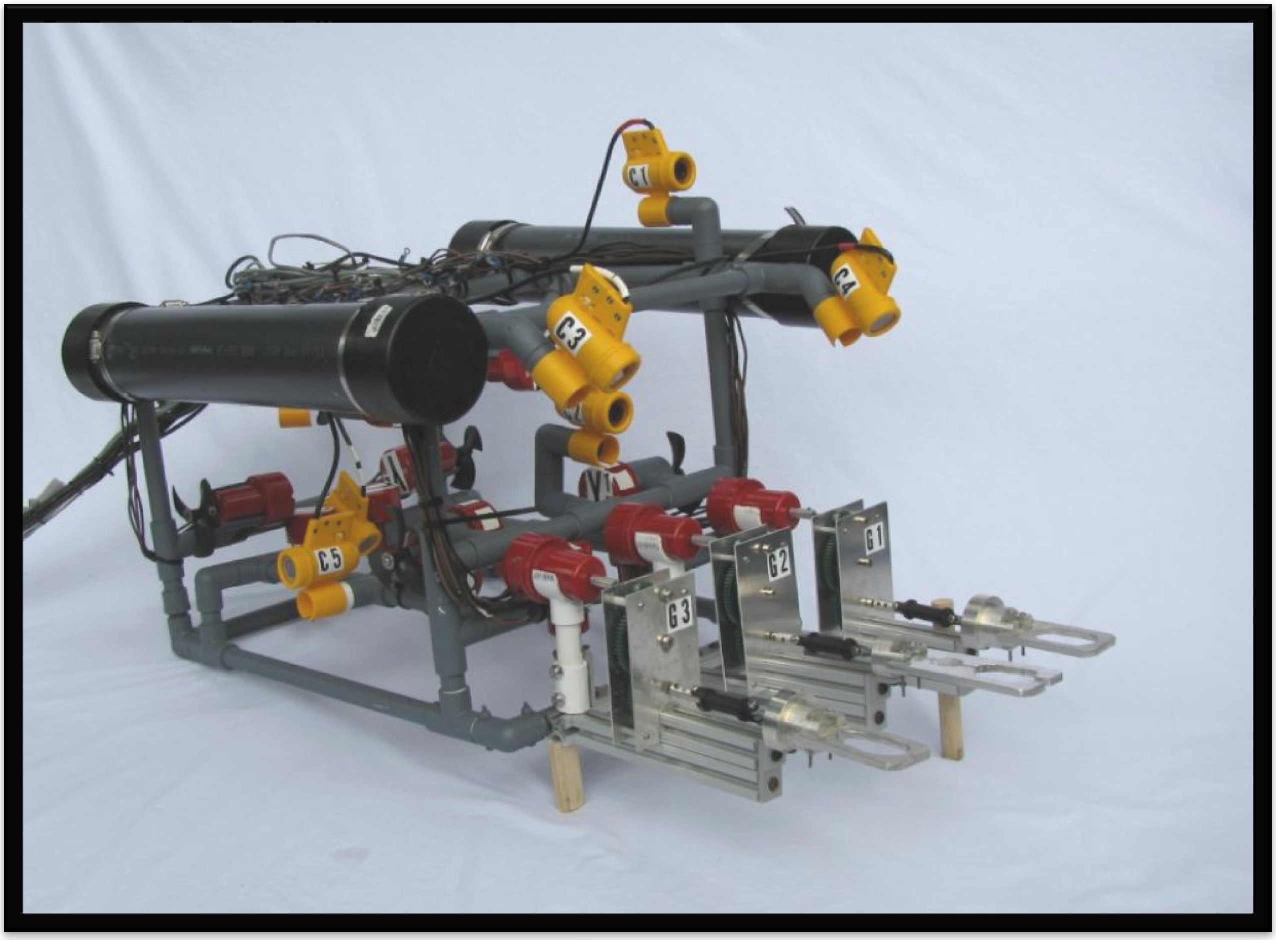
Abstract - ROV Overview

The 2009 Cornerstone Robotics team, which is made up of all new personnel, is a returning competitor to the MATE ROV Florida Regional and International competitions. The team's 2009 ROV, Peg Leg, is a built-to-purpose ROV, with specialized features to fit the specific mission tasks for this year. After studying various ROVs' construction and design we decide on these special features which include the three grippers, the versatile propulsion system, and the neutral buoyancy of the ROV. We decided on these features after testing different options during the construction of our ROV. The three grippers allow us fewer trips to and from the ELSS carousel and the hatch on the sunken sub. Our propulsion system, made up of twelve thrusters, allows us the greatest amount of maneuverability in forward/reverse, lateral, and vertical movements. The system also enables our ROV to rotate around the vertical axis. Because of this greater mobility, we are able to make our ROV buoyantly neutral which bypasses the need for adjustable ballast. The neutral buoyancy also gives the ROV a versatile balancing system to account for depth changes and to adjust the trim of the ROV quickly and easily. The primary goal for our ROV was achieved by having design concepts that focused on making Peg Leg versatile and adaptable to the different tasks that are encountered during the competition.

The Completed 2009 ROV: Peg Leg



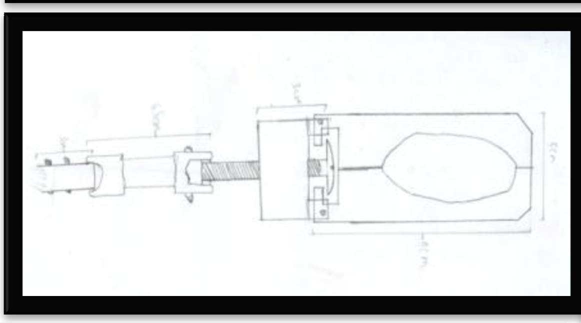


Image1(Top): The Completed ROV: Peg-Leg

Image2(Above): An early gripper sketch

Image3(Right): The most prominent feature on the ROV, the three grippers

Budget and Expense Sheet

School Name: Cornerstone Acdemy Robotics
Instructor: Jeff Knack
Overall Budget Report

Period: Rov Comp
From: 9/14/08
To: 5/27/09

Date	Deposit or Expense	Description	Vendor	Amount	Balance
9/15/08	Deposit	Family Fees	-	$1,750.00	1,750.00
11/6/08	Deposit	Car Wash	-	$268.00	2,018.00
10/25/08	Expense	Transistors	Digi-Key	($15.73)	2,002.27
10/30/08	Expense	Transistors, LCD Module	Digi-Key	($60.14)	1,942.13
11/7/08	Expense	Bilge Pumps	West Marine	($445.25)	1,496.88
11/24/08	Expense	Prop Parts	Home Depot	($88.41)	1,408.47
12/11/08	Deposit	O'Steen Brothers Inc.	-	$50.00	1,458.47
12/12/08	Expense	Prop Parts	Ferguson Enterprises	($3.18)	1,455.29
12/12/08	Expense	Prop Parts	Lowes	($14.93)	1,440.36
12/17/08	Expense	PVC Fittings	Zell's Hardware	($19.91)	1,420.45
1/8/09	Expense	Connectors	MSC Industrial Supply	($22.17)	1,398.28
1/10/09	Expense	PVC Fittings	Zell's Hardware	($2.22)	1,396.06
1/19/09	Expense	PVC Fittings	Zell's Hardware	($17.79)	1,378.27
1/19/09	Expense	PVC	Home Depot	($32.96)	1,345.31
1/20/09	Expense	PVC Fittings	Lowe's	($3.34)	1,341.97
1/20/09	Expense	Watertight Box	Allied Electronics	($109.37)	1,232.60
1/20/09	Expense	Cameras	Harbor Freight	($851.92)	380.68
1/26/09	Expense	PVC Fittings	Lowe's	($11.40)	369.28
1/26/09	Expense	Fasteners	Zell's Hardware	($8.45)	360.83
1/27/09	Expense	O Ring	Zell's Hardware	($0.63)	360.20
1/27/09	Expense	Taps and Drills	Florida Fasteners	($56.89)	303.31
1/30/09	Expense	PVC Fittings	Ferguson Enterprises	($16.67)	286.64
2/2/09	Expense	Joysticks, Switches, Box	Digi-Key	($55.35)	231.29
2/5/09	Expense	Wire	Skycraft	($23.55)	207.74
2/7/09	Expense	Water Proof Connectors	Maryland Metrics	($60.87)	146.87
2/10/09	Expense	Wire	Graybar	($136.52)	10.35
2/10/09	Expense	Gears	Trossen Robotics	($33.85)	(23.50)
2/18/09	Expense	Machining	Innovative Machine	($34.69)	(58.19)
2/19/09	Deposit	Scrips Program	-	$600.00	541.81
2/27/09	Expense	PVC Fittings	Lowe's	($2.77)	539.04
3/2/09	Expense	Wire	Pepboy's	($37.87)	501.17
3/4/09	Expense	PVC Fittings	Lowe's	($5.18)	495.99
3/4/09	Expense	Hardware Cloth	Lowe's	($7.46)	488.53
3/5/09	Expense	Half Shafts	Hobbyland	($13.61)	474.92
3/6/09	Expense	80/20 Parts	HPE Automation	($90.72)	384.20
3/10/09	Expense	Propellers	Harbor Models	($81.00)	303.20
3/13/09	Expense	PVC Fittings	Home Depot	($24.75)	278.45
3/13/09	Expense	Aluminum Stock	MPH Industries	($32.03)	246.42
3/16/09	Expense	Fuses, Holder	Pepboy's	($9.59)	236.83
3/18/09	Expense	Bolts	Zell's Hardware	($5.87)	230.96
3/20/09	Expense	Switches, Control Box	Digi-Key	($49.22)	181.74
3/26/09	Expense	ABS Pipe, Electrical Connectors	Home Depot	($13.93)	167.81
3/30/09	Expense	Prop Letters, PVC Fittings	Home Depot	($28.32)	139.49
3/30/09	Expense	Display Board	Office Depot	($32.00)	107.49
3/30/09	Expense	Threaded Rod	Home Depot	($1.25)	106.24
4/3/09	Expense	Battery	Interstate Batteries	($221.44)	(115.20)
4/8/09	Expense	Switches	Digi-Key	($30.30)	(145.50)
4/11/09	Deposit	Refunds	-	$42.29	(103.21)
4/13/09	Expense	Caulk Rod	Home Depot	($8.31)	(111.52)
4/18/09	Deposit	Video Ray	-	$100.00	(11.52)
4/18/09	Deposit	Crockett Foundation	-	$200.00	188.48
4/28/09	Expense	Poster Board Supplies	Office Depot	($60.07)	128.41
5/2/09	Expense	Wire	Skycraft	($88.53)	39.88
5/4/09	Expense	ABS Caps	Lowe's	($18.52)	21.36
5/13/09	Expense	Propellers	Harbor Models	($57.50)	(36.14)
5/15/09	Deposit	Refunds	-	$43.64	7.50
5/18/09	Expense	Letters and Numbers	Home Depot	($8.48)	(0.98)
5/24/09	Expense	Team Shirts	Old Navy	($106.80)	(107.78)
Various Dates	Expense	Non-MATE competitions	N/A	($521.55)	(629.33)
	Deposit	Family Fees	-	$629.33	0.00

Electrical Schematic of the 2009 ROV

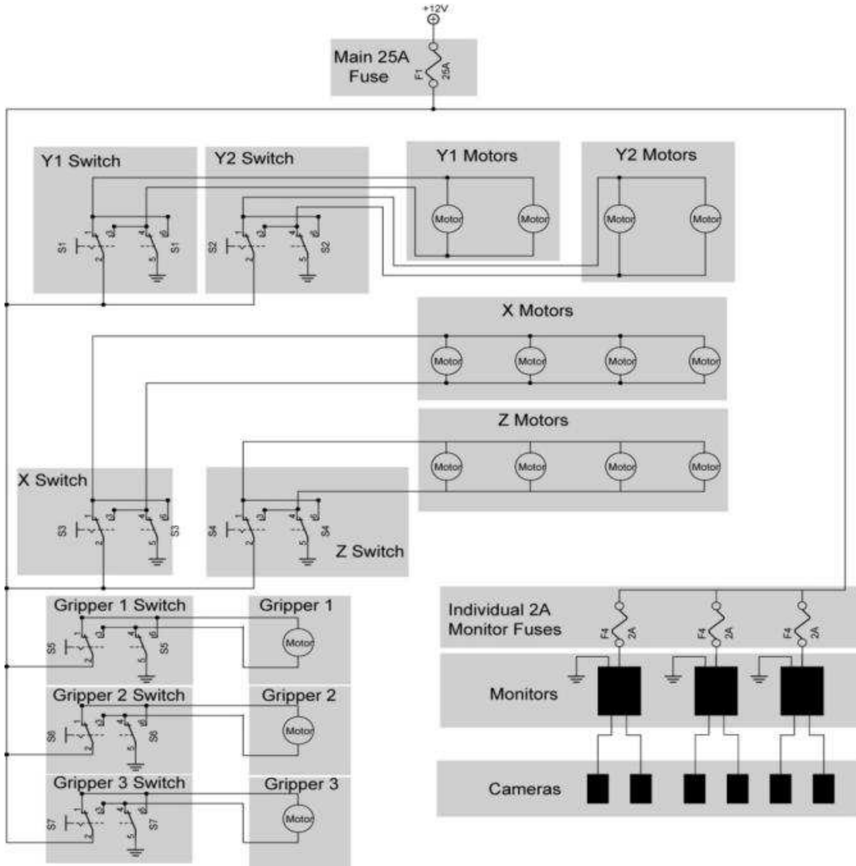


Image 4: The electrical schematic of the power Distribution on the ROV. Included are: the DPDT switches, the 15 motors used for propulsion and gripper control. Propulsion motors include Y1, Y2, X, and Z. Also Included are the monitors and Cameraswhich run off the main power supply.

X=Forward/Reverse

Y=Lateral/Turning

Z=Vertical

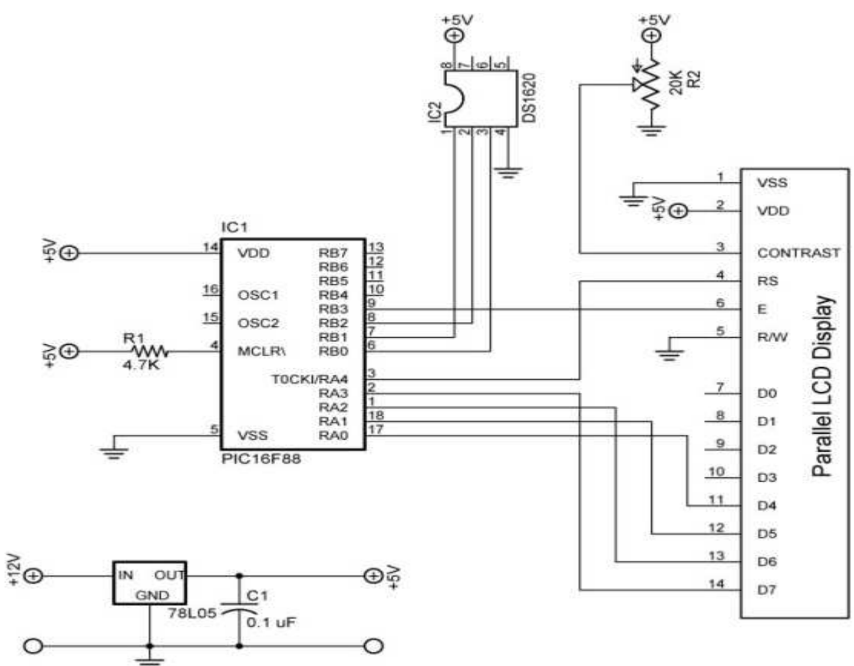


Image 5: The electrical Schematic for the one of the sensors on the ROV: the digital thermometer. The thermometer will send the temperature of the surrounding water to the LCD read out which will be on the control shack.

Design Rationale

Frame Design

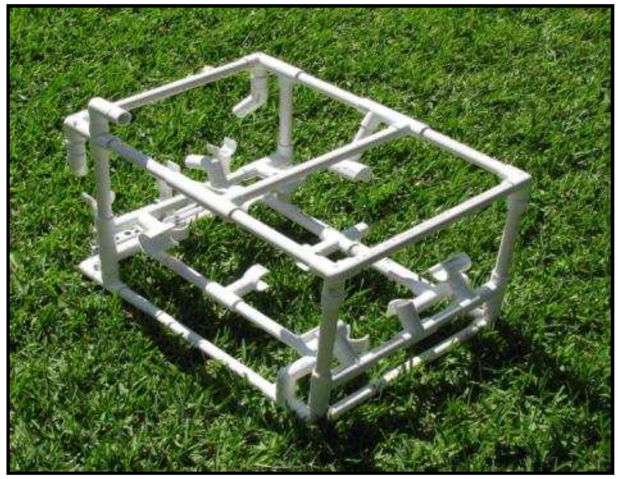


Image 6: The frame of the ROV before the motors, cameras, and electronic wiring are assembled.

The first step in fabricating the ROV was constructing a frame that was not only sturdy but could support all of the various ROV systems. To do this we used ½" (1.27cm) PVC because it is light weight, easy to fabricate, and inexpensive. After the Florida Regional, we scaled down the frame, cutting out .91 kilo grams of unnecessary dry weight. The length of our final frame design is 65 cm, the width is 55 cm, and the height is 41 cm. The length is 65 cm to decrease the turning radius, the width is 55 cm, the minimum width that could fit three grippers, and the height is 41 cm so that our thrusters would not interfere with each other. We made two crossbars that run the length of the ROV, one on each side at the bottom, to add stiffness and durability to the frame. We have two additional crossbars that run the width of the ROV, one in the middle at the top and one in the front at the bottom. These crossbars aid in the ROV stiffness. On the bottom of the frame we attached a wire mesh to keep the string/air line from being pulled into the vertical thrusters and for safety precautions.

Buoyancy System

When designing the ROV, one of the main features we choose to incorporate was neutral buoyancy. To give neutral buoyancy to our ROV, we used 7.6 cm ABS pipe. We chose ABS pipe instead of PVC pipe because ABS pipe is lighter than PVC. This enables us to use less ABS pipe which cuts down on the ROV's mass and drag. After finding the ROV's weight in water we adapted Archimedes Principle to find the length of ABS needed (See Table 1). To have our ROV buoyantly neutral the buoyancy force equals the ROV's weight in water. We calculated that we would need to use a total of 106.7cm of ABS pipe or two 53.35cm lengths of ABS pipe measuring 7.65cm inside diameter. Also in order to fine tune the buoyancy, we put a long screw at each bottom corner of the ROV. These serve as attachments for washers using wing nuts, which weigh our ROV down to the desired buoyancy. Not only can we use this to change our buoyancy, but we can also use this for the trim of our ROV. If our ROV is leaning too far forward then we either take washers off the front or put more onto the back.

Table 1

Known Variables:	**Archimedes Principle:**
Weight in Air: 14.5Kg or 142.2N	$F_B = \rho_w gV$, since $V = (3.14)r^2L$
Weight in Water: 4.9Kg or 48.05N	$F_B = \rho_w g \times (3.14)r^2L$
Density of Water (ρ_w): 1000Kg/m^3	$L = F_B / \rho_w g \times (3.14)r^2$
Force of Gravity (g): 9.8N/Kg	$L = 48.05\cancel{N} / (1000\cancel{Kg}/m^{\cancel{3}})(9.8\cancel{N}/\cancel{Kg})(3.14)(.03825\cancel{m})^{\cancel{2}}$
Radius (Inside) of ABS (r): 0.03825m	$L = 1.067\cancel{m}(100cm/\cancel{m})$
Volume of ABS(V): $(3.14)r^2L$	**L = 106.7cm**
Force In Buoyancy (F_B): 48.05 N	

Table 1: Buoyancy Force Calculation

Control System

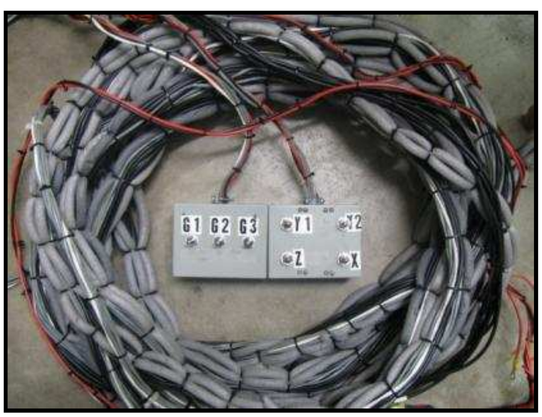


Image 7: The two control Boxes and the tether connecting to the ROV.

Initially we attempted to create a software system, utilizing a joystick, for the control system. Realizing, that this was an intricate process we set a deadline, February 1. As the deadline passed we could not complete the various systems needed for the joystick and conceded to using switches, a hardware only system, instead. This hardware system for the ROV is very simple and consists of 3 main components: the control switch boxes, the tether, and the terminal strips. The simplicity of the control system makes this vital part of the ROV reliable and effective.

The switch boxes are used to operate the ROV from the surface of the water. We built two switch boxes in total: one for the grippers and one for the propulsion system. The switch box for the grippers contains three DPDT switches, one for each gripper. Each switch will either open or close the gripper they control by reversing the polarity to the bilge pump motors that drive the grippers. The switches controlling the propulsion system work in the same way as the switches for the grippers. Similar to the gripper switches, when the switches for the propulsion system are thrown in opposite directions they rotate the propellers in opposite directions.

Another vital component for controlling the ROV is the tether. It was very difficult to build a tether that could support the amperage we needed while also being lightweight. In addition to supplying the power to the bilge pump thrusters, the tether also had to include the cables connecting the video feed from our cameras to our monitors at the surface. The electrical wiring for the propulsion and grippers was designed by the team. Eventually we decided that 16-gauge wire, which can carry 10 amps, was sufficient to carry the necessary amperage while also being light enough for us to attach small amounts of foam backer rod to it. The tether's buoyancy prevented it from interfering with the mission props and the movement of the ROV.

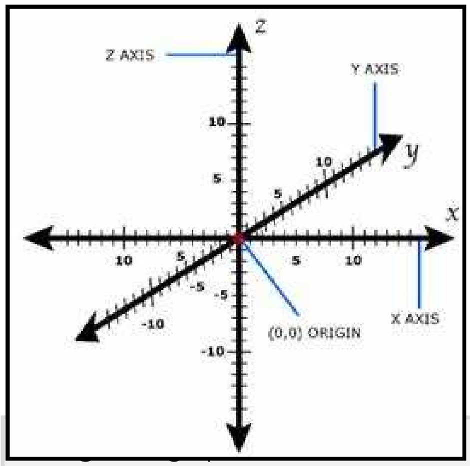
Monitoring System

One of the most visible features on board the ROV is the six cameras we use to direct the ROV in the pool and around the mission tasks. These six cameras give us a wide view of the entire area we are operating in and also allow us different views and angles of our grippers. This valuable perspective helps us finish mission tasks by allowing us to analyze the whole situation by giving us several views of the entire area. Because depth perception is very unreliable on our monitors, these cameras allow us to better perceive distances by giving us two perspectives instead of only one. Having these different perspectives and being able to perceive the area around us is invaluable when operating our ROV.

Image 8: One of the six cameras used to monitor and operate the ROV. Cameras were essential to the ROV.

Propulsion System

An initial feature we planned for the ROV was a versatile propulsion system. We achieved this by creating a system of twelve modified bilge pump motors that are converted to thrusters, providing 4 thrusters for each of the X,Y, and Z axis. We began with adapting bilge pumps so they could be used for propulsion. After removing the pumps' propellers so that we could attach it to our ROV, we mounted our propellers to the bilge pump motor shafts. Because we took the pump out of the bilge pump, it could now be used as a propulsion motor. The propulsion motors operate at approximately 8600 rotations per minute without a load. When it came time to decide on propellers, we had three different options. To test the three propellers, we used an Extech Instruments Model 475040 Digital Force Gauge and a digital multimeter to determine which propeller had the most thrust with the least current (See Table 2). We then attached each of the three propellers to our ROV and timed a five-meter dash both forward and backwards to verify our force gauge's results. The timed forward thrust tests were consistent and the three-blade, 60mm propeller gave us the most forward thrust with the least current as well as the best five-meter dash time. We have four forward/reverse (x) propulsion motors on one switch, four vertical (z) propulsion motors on another switch, and four lateral (y) propulsion motors on two switches. The lateral propulsion motors operate in two separate pairs, enabling them to rotate in opposite directions, one pair, (Y1) mounted in the front, the other pair, (Y2) mounted in the rear. This configuration allows the ROV to rotate on the vertical axis as well as facilitates lateral movement.



the ROV can maneuver on.

X= Forward and Reverse
Y= Lateral Movement and Turning
Z= Up and Down

Thruster	Forward Thrust	Reverse Thrust	Time Forward	Time Reverse
3 Blade 6cm	9.4 N at 5.5 Amps	2.15 N at 4.9 Amps	22.15 seconds	40.75 seconds
2 Blade 7cm	8.35 N at 6.6 Amps	3.35 N at 6.4 Amps	24.74 seconds	35.18 seconds
4 Blade 9cm	8.05 N at 7.3 Amps	4.45 N at 6.9 Amps	25.25 seconds	33.74 seconds

Table 2: Time Trials for the different propellers we considered for the ROV. We also compared the time to the amperage to select fast but efficient propellers for propulsion.

Challenges

Motor Speed

One challenge that our team had with our ROV was the motor speed driving the grippers and the amount of stress it caused on the connecting pieces. The problem was that we used cotter pins to connect the rotation bar from the gear box to the gripper drive shaft assembly. Even though the gear boxes we created for the grippers would slow the rotations of the shaft down to approximately 300RPM without load, the cotter pin would frequently break during the mission, disabling the gripper. Redesigning some part of the gripper system was the only option. The least time consuming change was to redesign the couplers, which had to be made to withstand the stress. We used the same aluminum rod but instead of a cotter pin, we replaced it with a #6 stainless steel screw. The screw was able to withstand the stress of the rotation and we have not had one failure since the redesign.

Image 10: The axel connecting the gear box to the gripper system with the new stainless steel screws replacing the cotter pins was much more reliable

Technical Report

Image 11: Working on Documentation for the Technical Report.

One of the biggest challenges we faced was not dealing with the mechanical or technical aspects of the ROV, but compiling the technical report describing them. We all had different ideas and personalities to compliment our different writing styles. It was challenging to put together this technical report, created by many different authors, because not one person on our team knew every detail of the ROV. The information we had to include in the report was contributed by most members of the team in order to complete it thoroughly. It took patience to get through even the shortest section at first but, in the end, we learned to cooperate with each other and offer constructive suggestions to complete our report on time.

Troubleshooting

In designing mechanical and electrical components for the ROV, we encountered many different errors and problems. To fix these problems, we used the basic flow chart (See Image 9) to work through them and develop a solution. After observing a malfunction, we tested, analyzed, and inspected the ROV to identify the source of the problem. After we had identified the source of the problem, we then developed and considered different solutions and selected one based on the efficiency, cost, and time effectiveness. Then we returned to redesigning the necessary components on the ROV and constructed the new or modified pieces to fix the problem. After incorporating the new pieces into the ROV, we then tested that part of the system or the whole ROV to determine whether the piece functioned effectively. During further testing, the piece would have solved the problem, partially worked, or would not work at all. If the problem was solved, then we had finished the troubleshooting process. If the piece partially solved the problem we would reconsider its design and modify it. However, if the new or modified piece did not function, we would then go back to reconsidering our previous solutions or by using our observation with the current piece we may develop new solutions.

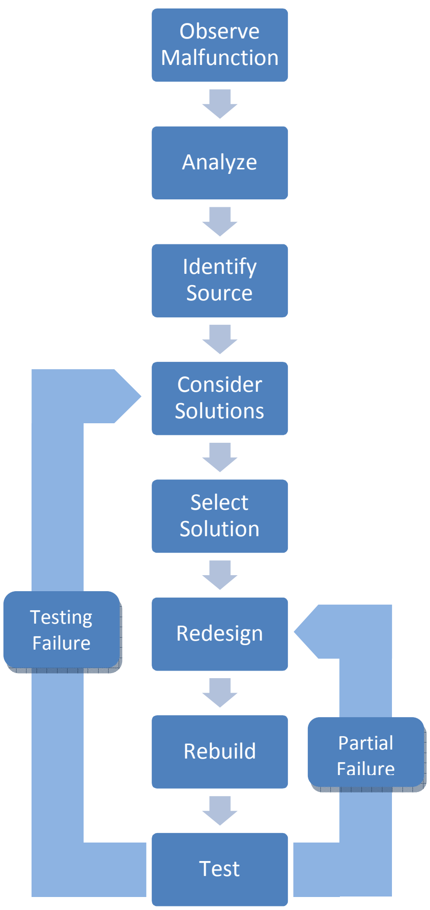


Image 12: A flow chart describing the troubleshooting process used to find solutions to problems on the ROV.

Payload Description – Gripper System

The most innovative system on the ROV is the unique three grippers that work individually or together to accomplish multiple tasks. The two outer grippers are simple and can be used for numerous assignments such as opening and closing hatches and lifting ELSS pods. The middle gripper is specially designed for holding the airline insert point. The middle gripper is similar to the adjacent grippers but it has a second hole behind the first one, which was drilled at forty five degrees for holding the air line at an advantageous angle. This allowed us to accurately insert it into the ventilation system inlet valve connection. A bilge pump motor is connected to a two stage gear reduction system, what we call the gearbox, which has a 25:1 gear ratio. Under a no load condition, the bilge pump rotates at a speed of 8600 rpm. The gear reduction system reduces this rotational speed to 344 rpm, in a no load condition. We measured the loaded condition rotational speed to be at 100 rpm. At this speed, we can easily control the gripper's opening and closing movements. A 1/4" x 20 machine screw connected to the gear box output spins through a tapped hole in the gripper base, pushing the notched gripper pieces forward, opening the gripper. The gearboxes, grippers and gripper bases were all designed and manufactured entirely in the Cornerstone Robotics shop by the team members, while the bilge pumps motors were also modified by team members. The intricate process of milling, drilling, and turning took several months to perfect, and several substitute pieces were made for emergencies during competitions. We chose to use three grippers for picking up the three ELSS pods at once, saving a valuable amount of time. An important add-on is a wooden dowel, hence giving the name “Peg- Leg” to the ROV. The peg-leg is used to lock and unlock the valve, and is connected to the far left gripper system, and is used to lock and unlock the ELSS pod hatch. Having three grippers provides redundancy in case of gripper malfunction, as happened in testing. It also allowed greater versatility and creates an advantage over ROVs with only one gripper. This is especially true in the pod posting and ventilation missions, where we have alternative grippers on board in the event of malfunctions.

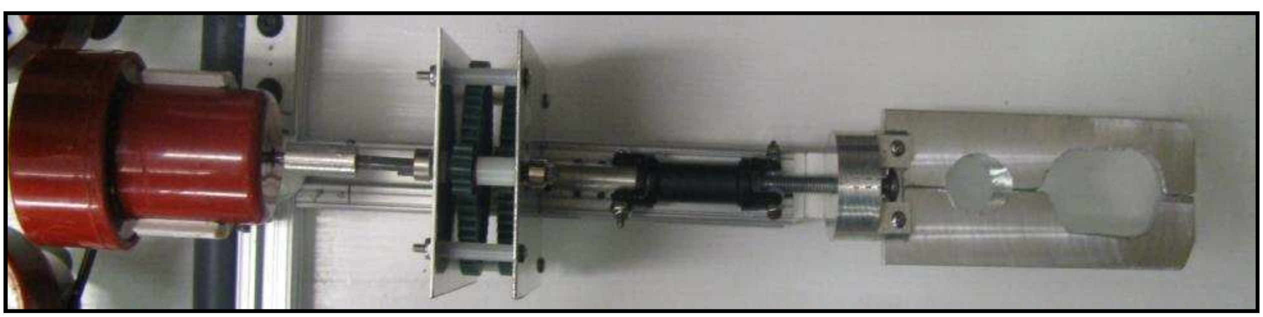


Image 13: The entire gripper system: (from L to R) the Bilge Pump, The Coupler, The Gear Box, The Drive Shaft Assembly, The Gripper Base, and the Center Gripper.

Future Improvements

Different Motors/Propulsion System

Image 14: The BTD150 by SeaBotix was one thruster we considered for propulsion.

Our propulsion system, composed of twelve 8600-rotations per minute bilge motors, is adequate for our purposes but does not provide the forward speed we would like. Because our thrusters are modified bilge pump motors, which are not designed for propulsion, they could not function as efficiently or quickly as other types of thrusters. Some other thruster selections we looked at were more powerful and consumed less amperage than the bilge pump motors. This major advantage of an alternative thruster selection would have made our ROV faster and more effective.

Joystick Control System

Image 15: The Joystick we tried incorporating into the control system.

One of the earliest design concepts of our ROV was to have a fully functional joystick that could be used to control the three main axes of rotation: vertical, lateral, and forward/backward movements. This joystick could also be used for variable speed control which would allow for more accurate movement when we needed it. However, as time went on we found we did not have the needed time to complete the intricate circuit and the program that would accompany it. Instead we replaced the joystick with single pull, double throw switches. While this was an effective solution, it did not offer the ease of movement and the variable speed control we wanted the joystick to have.

Lessons Learned

Looking back through the MATE ROV design and construction process, the 2009 Cornerstone Robotics Team has learned how to work together as a team to accomplish specific goals. When we could not meet our goals through our original plan of action, we worked as a team to develop alternative methods. While we learned some lessons during the construction and testing of our ROV, other lessons were learned through making mistakes during competition.

During the design process, we learned that a slower ROV will operate more efficiently. In many of the missions we needed to move just a few inches. If our ROV was too fast, we would not be able to operate with the necessary accuracy when making precise movements. Because our ROV is slower, we are able to move small distances very accurately. This helps us accomplish every mission quickly and efficiently.

While testing our model, we learned the importance of keeping spare parts with us during test missions. Because our testing location was separate from our workshop, we would often have to make extra trips between the two when a part broke or needed adjustment. This lesson proved beneficial when we brought all of the parts needed to fix problems to the 2009 Florida Regional Competition. As a result, we were prepared for unexpected malfunctions.

A more difficult lesson was learned too late when we were already at regional competition. When a propeller coupling broke, we installed a replacement propeller with a similar coupling. Unfortunately we put the propeller on the wrong way and the propeller went in the opposite direction of the rest of the propellers. Because this error affected the Z-axis, we descended at an incredibly slow rate. This untimely lesson taught us to double-check our work before the competition, making sure that everything is done correctly.

Description of a Submarine Rescue System

Deep Submerged Rescue Vehicles (DSRVs) are specially designed crafts that aid passengers aboard submarines that are disabled and need assistance. The U.S. Navy needed such a craft during a tragic event that occurred in late 1963. U.S. Navy USS-593 *Thresher* was the lead ship of her class of nuclear-powered attack submarines. However, during a routine docking, *Thresher* received substantial damage to her ballast. After the faulty repair of the ballast system, she was back in training. On her final

Image 16: The US Navy's DSRV mating with another submarine.

expedition, April 10, 1963, the USS-593 had reported “minor difficulties” during deep-sea trials. Due to a frozen pipe connecting the air tanks to the ballast, *Thresher* and her crew lost control and plummeted to their deaths. A new demand for deep sea rescue was imminent. The need for deep submerged rescue vehicles (DSRV) has now been satisfied by two outstanding, manned crafts: the *Mystic* (DSRV 1) and the Avalon (DSRV 2), both commissioned in 1972. The vehicles are designed to dive 5,000 feet, fasten themselves to another vehicle, mate, transfer crews to safety, and ascend at 100 feet per minute.

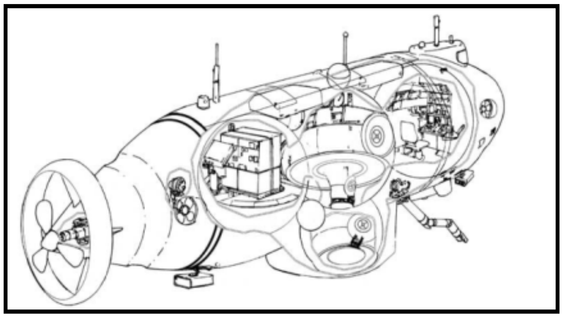


Image 17: A schematic of the DSRV showing the different apparatuses.

The DSRV's apparatuses function similarly to the ones found on the Cornerstone Robotics team’s ROV. Both are equipped with transfer skirts to facilitate crew transfer. Also, both the DSRV’s and ROV have optical devices to locate and maneuver around a distressed submarine. However, unlike the DSRVs, ROVs have cameras, DSRV’s have sonar. Also ROVs are not designed to dive to depths that are otherwise unreachable, due to their tethers, or give life support to downed vessels. The intended design for both devices is to aid those in peril. The DSRVs are capable of going where it is unsafe to send personnel. Carefully chosen and placed devices on the DSRVs assist the crew through their intense mission: diving and locating submerged vessels, making repairs on downed vehicles, or recovery of personnel.

Image 18: The DSRV being loaded into a C-5 for transport.

The U.S. Navy has experimented with many vehicles and tools to aid deep-sea rescue. DSRVs *Mystic* and *Avalon* have been selected as the preferred vehicle for deep submergence rescue. Since their production, these DSRVs have been constantly prepared to be called upon to perform any necessary task; they have demonstrated themselves and have attained worthy status. A training scenario was set into motion on June 16, 2001. A Swedish submarine, the *HMSwS Gotland*, simulated a downed vessel and the *Mystic* (DSRV 1) worked flawlessly on her training mission. At the time, the *Mystic* was at its home base in Groton, Connecticut. It was then loaded on to a C-5 Galaxy, flown to England and then transported on the mother ship, the *HMS Vanguard*, to travel to Scotland where the simulation took place. The *Mystic* dove to a depth of 450 feet, mated with the *Gotland*, oriented itself back to the mother ship, the *HMS Vanguard*, and successfully re-mated there. That day the *Mystic* established its superiority above all other aquatic rescue crafts.

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Reflections of Major Contributors

Josh Davis

After building many different small parts, I found the gearboxes to be the most challenging. It was difficult to match the holes in the two plates that aligned the gear shafts. Because we had a failure in two of the gearboxes, I had to rebuild both of the boxes. As time was running out, I found that team work is invaluable as we still had many things to complete on the ROV.

Brad King

Participating in the ROV competition has been an invaluable experience. Through it I have not just learned about marine engineering but about engineering design and construction in general. I have learned to work as a team rather than individually and to find solutions even if they are hard to find. The MATE ROV competition was different than the various robotics competitions I have participated in and through it I learned several different problem solving techniques and design processes that I will use no matter which profession I proceed to go in to.

David Ku

When the decision was made to create and use three grippers on the front of the ROV, I was assigned to the task. Unfortunately, I was intimidated by the large machinery. Working with the heavy machinery, such as the lathe, milling machine, band saw, and drill press has made me become more confident in myself. I manufactured the grippers in order to pick up three ELSS pods at the same time and to perform other complex tasks such as opening and closing doors. This took a lot of technical skill and patience. It is an accomplishment that I am particularly proud of. Although I enjoyed working to create the grippers, I realized that I am not interested in pursuing engineering or working with machinery as a career.

John Marchand

Through fabricating of the ROV I have become more proficient in my abilities to use power tools and measuring instruments. I am more confident in designing and constructing functional devices and accomplishing specific tasks. I have also learned the importance of measuring materials before I cut them. This has decreased the number of times I have had to remake components. This competition has solidified my desire to pursue mechanical engineering in college and as a career. This is because through the competition I have found my "knack" for designing and constructing mechanized devices. Also, the MATE ROV competition has taught me that mathematics is useful outside of the classroom.

David Shepard

Flexibility, I never quite understood the definition of the word until preparation for MATE. Not only, did I have to help people with random tasks, but also I had different areas to work on daily. One day I would work on the ROV’s frame, the next I would work with the tether, the fallowing meeting I would work with soldering and wiring. Along with the randomness of tasks, there was a verity of people to work with. As well as a verity of tasks, I had to be flexible about my ideas. I would plan a scheme and have to give up on it because it wouldn’t work or other people wanted to go with their ideas.

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