2011

UH HILO ROV TEAM

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BIG ISLAND ROBOTICS

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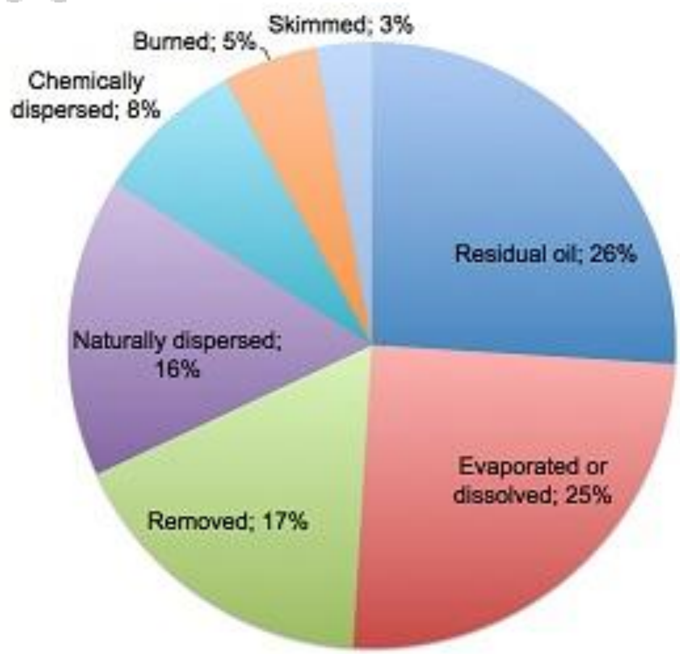
Abstract

The University of Hawaii at Hilo is attending the 2011 MATE (ROV) competition in Houston, Texas June 16-18. Our team will be the first team to attend the MATE competition in the explorer class from Hawaii. The purpose of this year's competition is to complete three tasks involving: Cutting a riser pipe and capping a well head (removing a riser pipe and stopping the flow), collecting water samples at various depths, collection of multiple benthic organisms. C.O.R.I. (Controlled Oceanographic Remote Instrument) is the ROV, that our team has designed and constructed and will be used in the 2011 competition, held at the NASA Johnson Space Center in Houston, Texas. The design was put into Solidworks and the construction was based on these design ideas. The frame was constructed from ¾" EMT conduit, which gives the frame a sleek and light design. The conduit was bent and welded into place by our team members and came close to the design ideas we had made on Solidworks. The frame design is the key to our design and has proven to operate in the water column as we had expected. A functional gripper/claw was also designed, using a gear reduction motor housed in aluminum tubing, capped, welded, and sealed to provide maximum protection from any water penetration. The gripper/claw is a functional versatile tool that can be used in multiple task situations. The thrusters were designed from converted bilge pumps and several propeller designs were tested for best performance and efficiency. The UHH team has spent over 200 combined hours designing, constructing, troubleshooting, and testing parts for the tasks that will be completed at this year's MATE competition.

Deep Water Horizon Oil Spill

The Deepwater Horizon oil spill also known as the BP Oil Spill has been acknowledged as being the largest marine oil spill in history. Releasing almost 5 million barrels off of the Gulf of Mexico, oil spills such as the 1968 spill Mandoil II cannot compare in the amount of oil spilled and the amount of destruction being created. On April 22, 2010, the Deepwater Horizon sank in 1,500 m of water causing crude oil to free flow into the surrounding area. In order to determine the amount of oil flowing from the well, Remote Operated Vehicles (ROV's) were enlisted to investigate the area and to determine the flow rate in barrels per day. The first few attempts showed no oil leaking from the well, however, by April 23rd 2010, two leaks were discovered, one from a kink in the riser above the blowout preventer and a primary leak from the end of the riser, where it had broken off from the rig. The initial attempt to shutdown the flow of oil was unresponsive as the safety device called a blowout preventer (BOP) was unable to be activated. The flow continued to free flow for nearly 86 consecutive days and over 75,000 square kilometers before finally reaching a state of manageability.



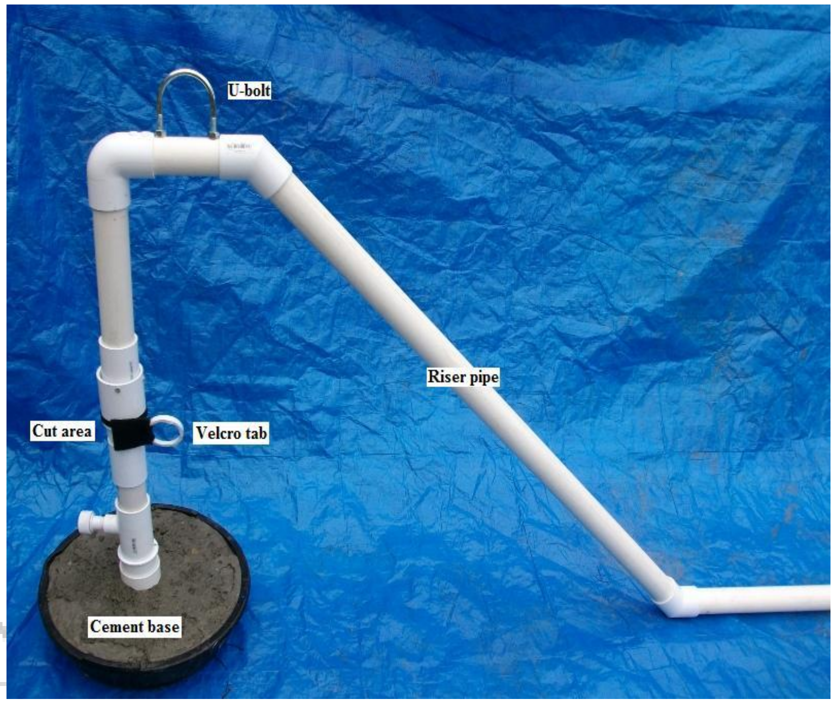
Design Rational – Missions

Planning and design started when team members were approached by the ROV club president about joining the ROV team and going to the MATE competition in Houston, Texas. The first meeting was held in December 2010 and ideas for the ROV construction were discussed at this time. The team was open to all students and it was decided to start fresh after finals, and Christmas break. January 2011 was opened with team members having meetings and starting construction on the ROV. The planning process was followed by weekly meetings and the team members were decided at this time. There was not much support from students in joining the team, so what few team members there were just had to work harder and faster. Having a small team led to limited idea basis, but got the team to rally and decide quickly on the best way to design the ROV for the tasks at hand.

The team members had knowledge of the marine environment, dive experience, mechanical, and welding skills that helped to ensure a solid working ROV design. The frame design has been the biggest success and proved that having a slim open space allowed better maneuverability and room for attachments. Competition rules helped to define our design ideas and the frame design worked around the tasks at competition. The task of attaching a line to a riser pipe and pulling the piece from the rest of the task proved to the team that the ROV would need multiple camera angles and three camera designs were included on the ROV. Having a wide field of view from multiple angles ensured the safety and maneuverability of the ROV. Using the gripper/claw design can also be multifunctional in carrying out the task of capping the open well head design. The gripper/claw design is a multi use tool that has a rubber gripped claw for holding on to the tools and tasks presented. The gripper/claws motor is a slower variable speed design that allows for precision gripping on all items. The rubber claws grip maintains on dry, as well as wet items. The task of picking up benthic organisms was easily adapted by the gripper/claw and proved to be an easy task to accomplish with this tool. The task of extracting the water samples posed as a challenge, but the team came up with attaching 12V gear reduction motor in a waterproof, aluminum housing, to a 140cc plastic syringe. The syringe has a flexible extended tube that can penetrate the task, like a hummingbird to a flower, enabling the ROV to maintain position and complete the task.

Task #1: Remove the damaged riser pipe

Our company must attach a line to the U-bolt on the riser pipe. We must provide this line, and design and construct a mechanism to attach it to the U-bolt. During the competition, a member of our company will hold onto the other end of this line as the ROV transports it to the bottom. Once the ROV has attached the line to the U-bolt, and has simulated cutting the riser pipe by removing the Velcro strip, we will be able to pull on the line by hand to move the cut-off portion of the riser pipe from the work area. For both RANGER and EXPLORER, a 10cm long, 5cm wide piece of Velcro loops will cover the Velcro hooks. A 1cm-wide ring of 1 ½-inch PVC coupling will be attached to the Velcro loops, centered in the middle of the strip. The strip does not completely surround the PVC pipe so if we are able to grab onto the ring of the Velcro strip the tab will be easier to remove. The Velcro strip will be attached to the riser pipe by a 0.5meter length of 1/8-inch nylon and polypropylene rope. Once the Velcro strip is removed from the pipe, it may be released by your vehicle. Once the line is connected to the pipe and the riser pipe is "cut," a member of your company can pull on the line to move the riser pipe away from the work area by hand. The ROV will not be required to lift the fallen riser pipe from the wellhead, however, if time permits we would like to try. Once the riser pipe is removed from the wellhead, you may pull it to the surface or deposit it on the bottom away from the work area. If the riser pipe is discarded on the bottom, it must not be touching any part of the remaining wellhead or the cement base to the wellhead.



Task #2: Cap the oil well

We must design and build a cap that fits onto the wellhead and stops the flow of oil (which is being simulated by water) emerging from the top of the wellhead. There are no restrictions on the design of this cap, provided that you adhere to the general design and building specifications for your ROV and rules on safety. Note that these specifications, and this event's rules, specifically DISALLOW the use of chemicals or other agents that might damage the pool or its filtration system or alter the water in any way, shape, or form. Such chemicals include adhesives, grease, oils, gels, resins, and other coatings. The cap must be able to be removed from the wellhead at the end of your mission performance period.

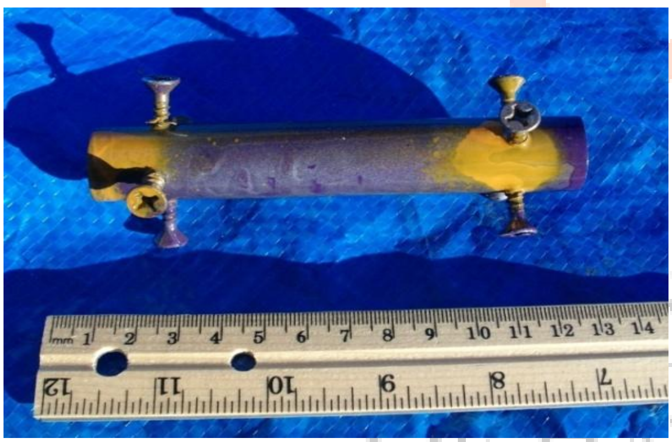
Task #3: Collect water samples and measure depth

The water to collect at the sampling sites will be simulated by super-saline, colored water in a container with a PVC pipe extending from the top of it. We will need to collect a sample through this ¾-inch PVC pipe. A red stripe on the pipe will mark the location at which to measure the depth of the sample. There will be three sample containers at different depths.

We will need to report depth data to the mission station judge in metric units. If our depth readout is in non-metric units, or the depth readout determines pressure, you are responsible for converting to a metric measurement of depth and reporting the metric value to the mission station judge. Our depth reading should be visible to the mission station judge on our ROV's video monitor or integrated into our ROV's control system or other device.   Our team must inform the judges when we are preparing to take a depth reading and when we are ready to have our measurement scored. The judge must see the reading taken by our vehicle.   The sample we retrieve must come up as a "pure" water sample from the container. Each mission station will have standard color samples to determine the purity of your sample and a graduated cylinder to determine volume. When the water sample is returned to the mission station judge, the judge will pour it into the graduated cylinder to determine volume. Then the judge will compare the sample against the standard. Points will be deducted for returning a diluted sample (i.e., a sample that is lighter in color when compared to the standard).

Task #4: Collect biological samples

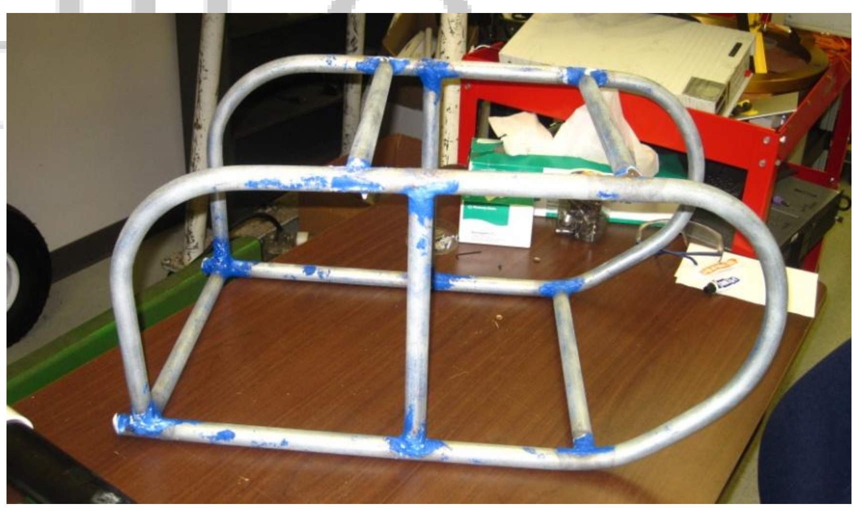
Our company's task is to collect samples of each of three specific benthic organisms and return the samples to the surface. The benthic organism samples must be brought to the surface without any damage to them to receive full points. In order to do this our team has decided to deploy a basket with our ROV, which will be initially dropped off on the bottom allowing for us to grab multiple specimens and safely bring the organisms to the surface all together.



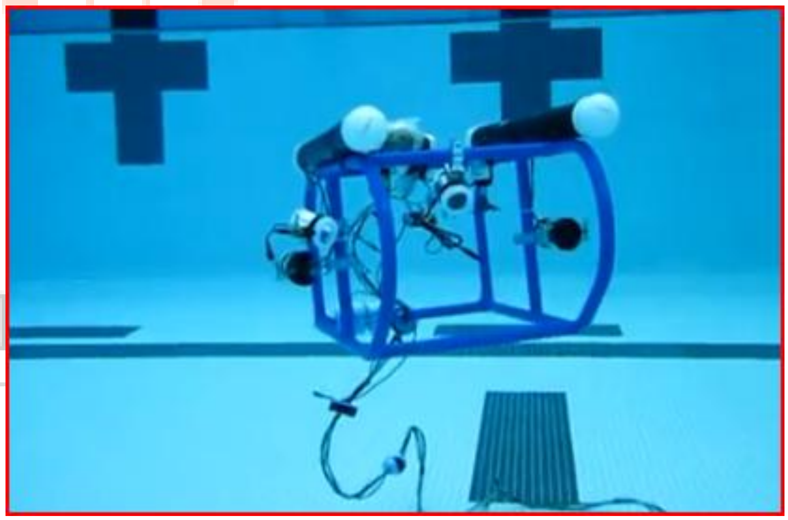
Design Rational – ROV

Frame

After much discussion and brainstorming we decided to use a welded metal frame. We understood we needed a robust frame to hold and mount the needed tools and manipulators that were going to be a part of the ROV. The frame design



was constructed from ¾" EMT conduit, which is a metal that is light, durable, easy to bend and shape. This allowed for rounded corners and turns to be made helping to decrease the negative factor of drag on the ROV in water. The team used an industrial conduit bender to shape and fashion the conduit to the desired shape, which is what makes our ROV design unique. We have a welder on the team and we utilized his skills to weld the conduit and seal it against flooding and rust. The frame design has become the backbone of our ROV and the team has been surprised at the maneuverability and control it has in the marine environment. The frame is 12" by 38", which allows for plenty of attachment points and leaves enough space to be hydrodynamic. The frame is sealed at the welds, using 3M marine sealant. The frames rounded edges gives the design less water resistance allowing the design to do the tasks in a controlled manner. Another advantage of using cylindrical pipe is that we can utilize off the shelf mounts for our thrusters and cameras that were typically intended for conduit tubing. Also by using a metal frame it is easier to reach neutral buoyancy by simply adding buoyant tubes versus adding weight to the frame to counteract our pressure vessels.



Thrusters

The thrusters used on the ROV were made from converting Johnson 500 bilge pumps into thrusters using propeller adapters and 50mm propellers. The propeller adapters were machined on a lathe by the team members and trials were conducted in a fish tank to test their performance. Different types of propellers were used in tests and the more efficient design was

picked. We settled on using 50mm propellers and 500 gph bilge pumps for many reasons. One of the main reasons is because the MATE control board developed by Scott Frasier had H-bridge motor drivers that were limited to 3amps of current with a max burst of 5 amps. As for refining of our designs we had to carefully choose which propeller to use because of our current limitation in our control board. The H-bridges that were supplied with the control board had a limit of 3 amps with a 5 amp burst. Although our current when tested in the water was only around 1.6 amps for a single thruster, when we tied two thrusters together they drew about 3.0 amps. We were worried that we would generate too much heat on the H-bridges and we might get a thermal shutdown of the motor drivers. Although we will be heat sinking the control board we wanted to have a decent margin of safety. In order to determine which propeller would provide the most thrust with the least amount of current draw, we conducted a bollard pull test and measured the voltage, amperage, and bollard pull. From this we could determine how much thrust was achieved with a delivered amount of power for a particular propeller size. We tested 3 2-blade propellers at 50mm, 60mm, and 120mm.

After running the bollard pull test it was determined that the 50mm propeller was the most advantageous. This is because it provided the most thrust (@ .277 kgf) with the least amount of current draw (@ 42.4 watts). Although there wasn't much of an increase in bollard pull between propellers sizes, we saw a significant reduction in power. This demonstrated that the 50mm propeller was more efficient while providing near equal amount of thrust as other larger diameter propellers. This would ultimately reduce the amount of heat generated by the H-bridges and allow us to tie to thrusters together to a single H-bridge to run the up-down thrusters.

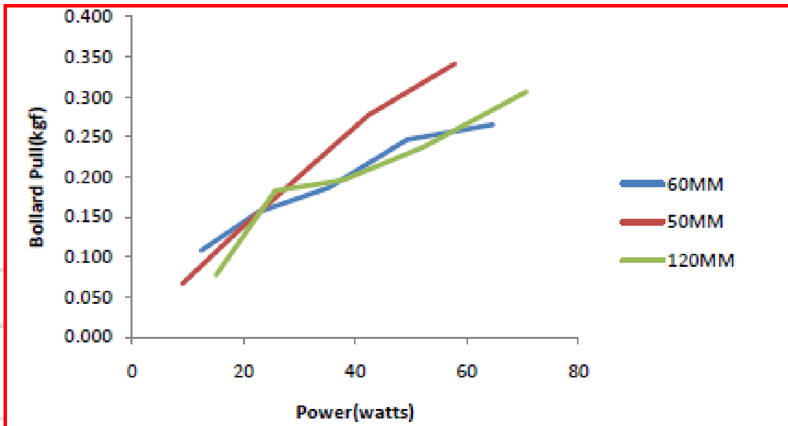


Figure 1. Curves of Bollard Pull vs. Power (watts) for 3 sizes of 2-blade propellers

Table 1. Table showing propeller size, bollard pull, and power respectively.

Prop size(mm)	Bollard Pull(kgf) @ 12v	Power(watts)
50	**0.277**	**42.40**
60	0.247	49.32
120	0.237	52.24

Also, 500 gph motors were donated from our supporters at the InfraRed Telescope Facility (IRTF). They also supplied us with propellers and propeller adapters. The Johnson 500's are durable water resistant motors that produce the power the ROV needs without hesitation. The ROV has four Johnson 500 motors for thrust and maneuverability. There are two motors for ascent and descent and a motor on each side of the ROV for forward and reverse directions. The motors are ran to the control board and tied into the tether system that is linked to the pilot's at topside. We constructed shrouds milled out on a lathe manually from PVC pipe to cover the propellers providing our ROV with the needed safety devices. The shrouds were also important in helping to direct water flow near the propellers, allowing us to get the most thrust available from our propulsion devices.

Gripper/Claw

The gripper/claw design proved to be a challenging yet fun design to come up with. The team looked at many different ideas and then decided to use a utility grabber bought from Ace Hardware. The claw on the end of this grabber is what got the team's attention. The claw is constructed of aluminum and has a rubber coating with larger pincers on the tips. The rubber has grip in the marine environment and allows for multiple uses on the ROV. The grabber had a claw design that the team wanted, but had to figure out how to convert it into a working attached arm. Using 1 ½” aluminum tubing the team machined down a 4” tube allowing room for a 12V DC gear reduction motor to be housed in. To waterproof the housing the team machined caps, shaft seals, and o-ring ports for the shaft to run through to attach to the coupling adaptor. The shaft of the grabber was cut with a saw to 12” and used as the primary portion of the gripper/claw mechanism. The motor shaft was attached to a machined screw drive that rotates the shaft to open and close the claw mechanism. The shaft and motor housing was sealed and coated with 3M marine sealant for water tight resistance. All the parts and labor were done by the team members.

Water Sampler/Extractor

For the water sampler the team decided to use a 140cc plastic syringe with a motor mount to run a machined screw driven adaptor like the one used on the gripper/claw. The leftover shaft from the original grabber was used as the shaft and the 12V DC gear reduction motor as the driver behind the extractor. The motor was housed in a 1 ½” aluminum tubing in which the team machined down a 4” tube allowing room for a 12V DC gear reduction motor to be housed in. To waterproof the housing the team machined caps, shaft seals, and o-ring ports for the shaft to run through to attach to the coupling adaptor. This design was copied off of the claw mechanism and sealed with 3M marine sealant. The design has a rubber shaft coating to prevent the plastic plunger from bending and coming apart. The extractor tip is integrated with brake line to form a hard surface to attach the rubber line that is used to penetrate the task for the water extraction. The unit is positioned vertically on the ROV and a camera angle will provide the coverage for guidance. The other thought behind having a rubber line for the extraction device was that the rubber will also bend/move out of the way when the ROV is performing its benthic tasks.

Cameras

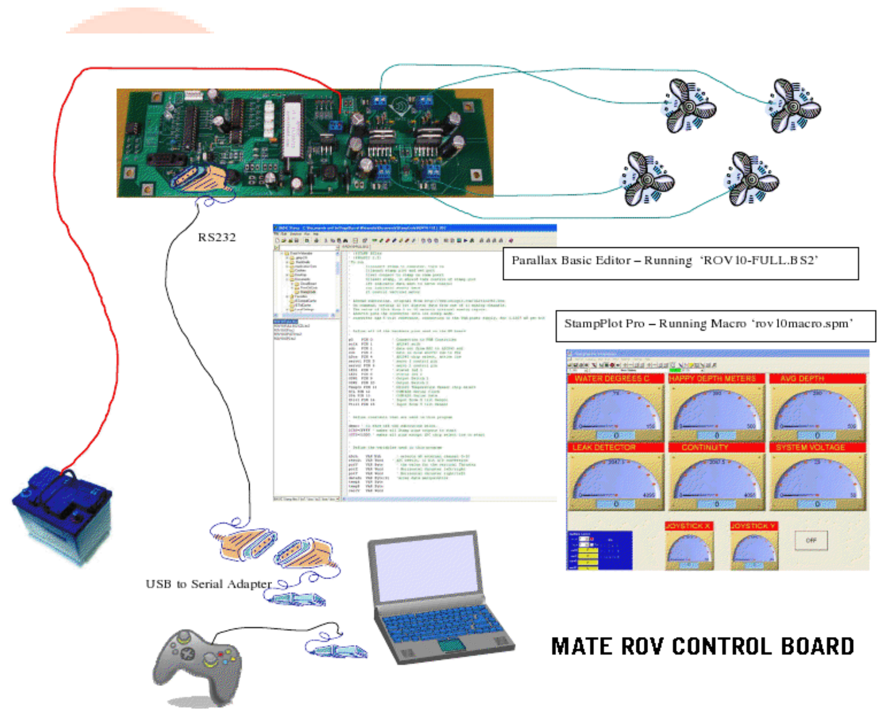
We are using a 3 camera system. One is a wide angle of 120 degrees and the other has a 90 degree field of view. We decided to go with a single 120 degree camera for our main navigational and piloting camera and we wanted to have the two other cameras dedicated to angles that would assist us in our mission tasks. These are CCD cameras with lens versus the commonly used pinhole cameras. They run off of 12 volts and draw about 200 milliamps each. They use NTSC video encoding. The team looked at numerous designs and ideas, before deciding to make the housings out of PVC pipe fittings. The PVC is light weight and easy to make housings out of. The lenses were made from Lexan and cut with a drill press by a team member. The housings were made using 1 ½" threaded reducer caps and the backing was a 2" PVC cap. The lenses were cut out to fit in the cap and the team used 3M marine sealant to make the lens water tight. A hole was drilled in the backside of the PVC cap to allow for the camera video lines to run out with the marine sealant waterproofing the cameras. The team tested the cameras in a fresh water tank and took note of any leaks, or problems. The housings proved to be durable and light weight, which added to the ROV's streamlined design. Using the three camera system has led to improved visibility and positioning for the task pieces. The wide angle lens provides a clear view for driving and maneuvering around the tasks.

Tether

The tether was donated to our team by the MATE foundation and gives us a 100 foot reach, which is more than what we need to accomplish the tasks, but gives us leeway for any error in tasks and use of the ROV in any situation. All components and parts were machined by the team and put together in a work shop.

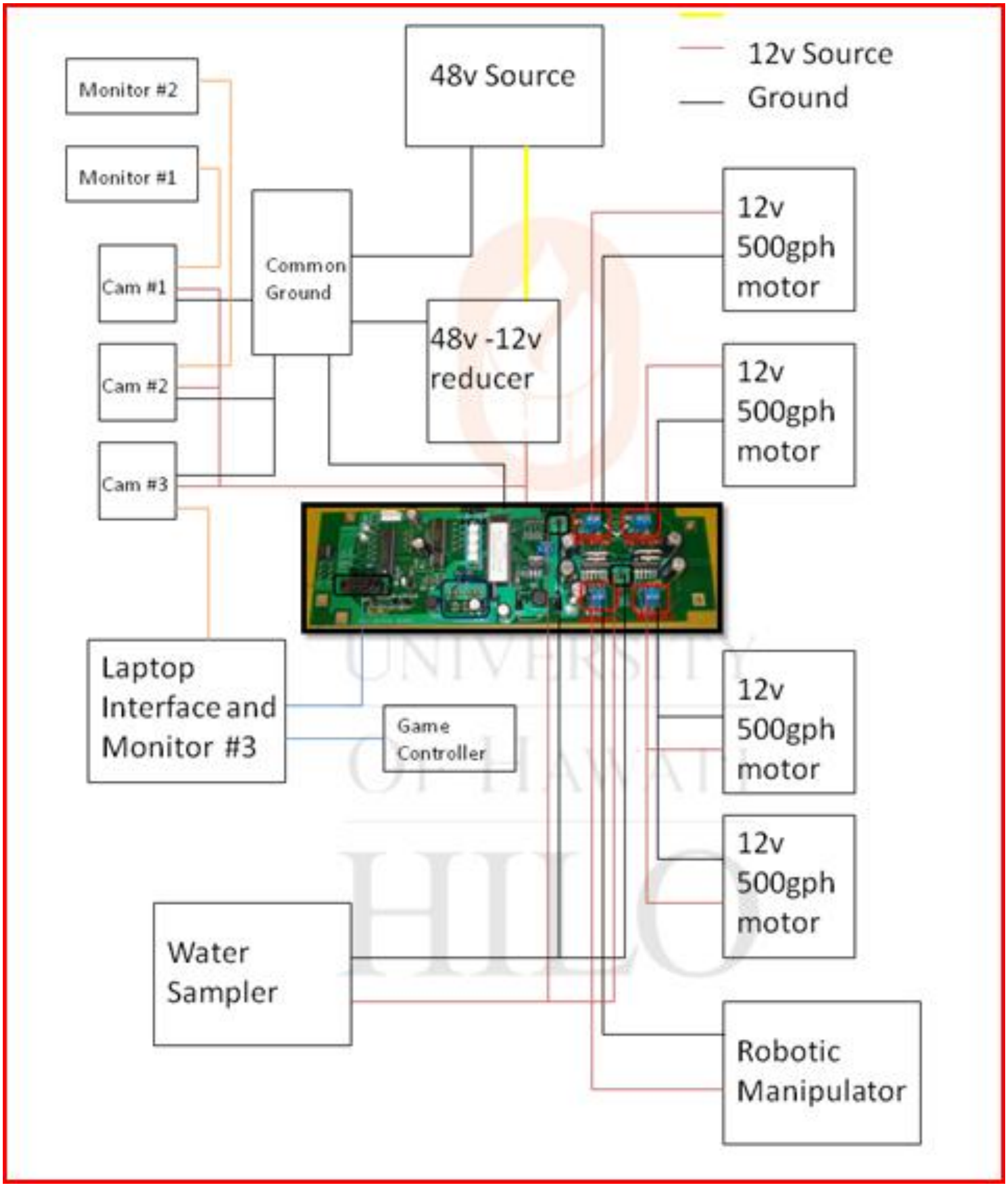
Control Scheme/Board

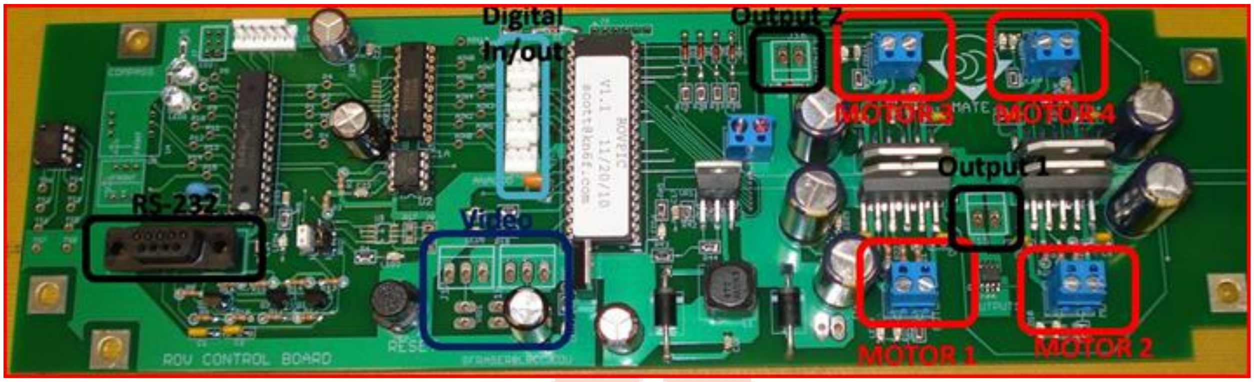
We used the MATE control board because Darryl Watanabe at IRTF was able to supply us with the control board and components. We assembled the control board as a team based on the schematics given and assembled accordingly with the use of tools necessary to complete the board. Also Darryl was a very good asset to gain consultation from as he was developing his own board as well. The board was equipped with H-bridge motor drivers (@input voltage), MOSFET outputs (@ input voltage), analog digital inputs, and a STAMP BASIC processor. There were also power and signal relays for cameras but we did not use them as they were designed for 5 and 9 volt cameras.



Although uncompleted at the time our design for the well head cap is going to be a spring activated cap that will work by being loosely attached to the well head by four aluminum arms with a lip able to fit in the groove. Once the arms are secured to the well head cap. Step two of the cap can be activated. This entails having above the cap a loaded spring activated by pulling or twisting a pin that will allow for the spring to unload providing the necessary pressure on the cap to stop the flow. On the inside of the cap design will be two sets of O-rings that will help to seal the flow of water from escaping from within the cap.

Wiring Diagrams





BUDGET:

item	quanitity	price per item	shipping	total	vendor
ABS adapter	3	2.36	0	7.08	Home Depot
PVC Cap	6	0.93	0	5.58	Home Depot
Grabber Nifty Nabber	1	19.99	0	19.99	HPM Building supply
ABS adapter	3	1.79	0	5.37	Home Depot
ABS ADPTR	3	2.02	0	6.06	Home Depot
ABS Adapter	1	1.63	0	1.63	Home Depot
#5SZCNDHNGR	8	2.42	0	19.36	Home Depot
#1CNDHANGER	1	2.89	0	2.89	Home Depot
PLASTBAGGDS	2	1.18	0	2.36	Home Depot
2ft ABS	2	3.85	0	7.7	Home Depot
2PVC Cap	6	1.34	0	8.04	Home Depot
Wide Angle Board Camera	1	69.99	55	124.99	SUPERCIRCUITS
Color Board Camera	3	39.99	0	79.98	SUPERCIRCUITS
2.1*3.5mm male Power Connector w/ flying leads	3	1.29	0	3.87	SUPERCIRCUITS
Pool Noodle	1	2	0	2	WALMART
1/8*2*5*18" Galvanized Pipe	1	21.35	0	21.35	HILO STEEL WORKS
HAIER 7inch HANDHELD LCD TV	1	49.98	0	49.98	AMAZON
VIDEO SECURE AV VIDEO AUDIO POWER CA	1	9.99	0	9.99	AMAZON
EASYCAP USB 2.0 AUDIO/VIDEO Capture devic	1	9.05	9.94	18.99	AMAZON
3pk electrical tape	2	2.01	0	4.02	WALMART
5pk plastic tape	1	4.14	0	4.14	WALMART
Push in connectors	1	1.89	0	1.89	Home Depot
2PT push in connectors	1	1.59	0	1.59	Home Depot
S3 T6000 DRY BOX COLOR YELLOW	1	58.95	0	58.95	BLUE RIVER ANGLERS
TOTAL + Shipping				532.74	

Challenges

The University of Hawaii at Hilo team encountered many challenges during the ROV project. Our biggest challenge was that the founding members had never constructed a remotely operated vehicle before and knew the challenges that adding the element of water would bring. Constructing the motherboard, choosing the right materials, and operating a vehicle by cameras were all a new challenge for the team. The team also faced a lack of support and involvement from the rest of the student body, which left only three team members for most of the construction process. The addition of two members late in the process was a welcome reprieve for the rest of the team and added a new energy that we needed to get through to the competition. Money also presented a challenge, as the team members had to put money from their own bank accounts into the project. Living in Hawaii also proved to be a challenge to our project. Hawaii is a remote island chain where waiting on parts, or finding part suppliers on the islands made getting everything by parcel a necessity. Getting packages to Hawaii takes a long time and the team learned early about ordering parts we needed in advance. These kinds of challenges made our team to be innovative, positive, and unique in our design processes. The team had to come up with designs that would work well and be sturdy enough to handle the pressures of a water environment. All five members are Marine Science students and had to balance a full load of classes, work part time jobs, balance families and relationships, and after all that still make time to construct the ROV.

Some other challenges faced were the result of the beaurocratic method. Early on our team captain was able to secure a funding pledge from Engineering Partners LLC of 500 dollars. This was enough to start developing the ROV and buying startup supplies and tools. However, at the time we were not able to receive the funds because we were not an associated group with the university, just a group of students with a common interest. Since Engineering Partners LLC could only write a check out to a non-profit organization we knew we had to become a UH associated group. Our team captain solved this by starting a Registered Independent Student Organization (RISO) called the Big island Robotics Club. This solidified our affiliation as a UH student independent club, However, at this point we were still unable to receive our funds. We had to continue to establish an account with the University of Hawaii Foundation so we could have non-profit status. We believe this is what hindered us the most; we could not receive the funds in time in order to purchase supplies in a timely manner. As a result it pushed back the whole rest of the development of the ROV. However, it turned out to be most advantageous, and not only for our team but for future students. Since the groundwork has been laid for the club and the UHH ROV team, we were able to solicit travel funding from University organizations. We were awarded 5700 dollars for travel because of the prospect of this type of student endeavors for future students.

Although we have had many setbacks and hindrances, we have still been successful in our efforts. Apart from living on a island in the middle of the ocean with limited parts suppliers, having a new team with no team members being experienced in ROV design, long process of having to develop an affiliation with the university from scratch, and lastly, being able to solicit funding for this project in the current economy with no previous success we have come a long way and we are confident in our design and believe that it will rise above some others.

Troubleshooting

We have dealt with many problems throughout our ROV construction. Mainly these have manifested from electrical problems due to both bad connections, and failures in waterproofing. This was to be expected because we didn't have the necessary expertise in either electrical engineering or underwater seals. We have gone through numerous prototype designs and hours of electrical testing to develop our ROV. There were times when we had short circuits between video feed wires and they were difficult to diagnose. However, after numerous testing attempts we believe we have worked out the flaws in our initial designs and have produced a more reliable vehicle based on the refinement of our prototype designs. What was especially challenging was producing a homebuilt ROV that can dive to 40 ft. This required much stronger and reliable seals for our electronics. We have also explored and attempted several designs for our waterproof housings for our cameras and our control electronics.

In order to test our components for waterproofing we tested the components without electronics at depths up to 60 feet to maximize our certainty in there waterproof design. Our team is composed of certified divers so this provided us with the luxury of being able to test our gear in the ocean. Due to this ability, we have been able to determine many faults in our initial designs and have refined them before incorporating them into the ROV, and more importantly before traveling to the Competition in Houston.

Reflections

Sebastian Baca:

During this competition, I have learned of what I am capable of. Since the 9th International competition held in Hilo, Hawaii, at the student life center where I worked and participated as a volunteer diver, I have worked from nothing to be on a team with skilled individuals that have accomplished the task of raising funds for travel from Hawaii to the Mainland US, developing a functional ROV that is operational at 40 feet, and successfully raising interest in the university community about robotics. As the team captain, I have learned to manage a team of individuals, how to go about soliciting donations, and about the buearocratic process of requesting funding for student activities. Furthermore, I have learned about electrical engineering, software engineering, underwater propulsion, 3D model design, and project development as I have taken the lead on those aspects. I have learned about the daunting challenges of finding team members to be involved, finding support to fund our ideas, managing a project of this scale without adequate team members, and networking with numerous individuals to accomplish several tasks. All in all, I believe I have a glimpse of what is truly like to manage a company that is involved in underwater technology trying to accomplish a specific requested task. I am very thankful I have gotten involved, this competition has pushed me to test the limits of what I am capable of, although I never thought it was possible. With all things, if we continue to persist and persevere we will eventually be successful.

Liz Clemens:

Over the past six months I gained many new experiences that will remain with me for the rest of my life. I have learned how to solder, wire electrical circuits, and work successfully with a team. These skills will be extremely useful for daily life, and will give me more advantages when applying for jobs than I had before I worked with the ROV team. I believe the International ROV MATE competition will provide me with new and long-lasting memories, better opportunities for jobs, and new learning experiences, and I am truly thankful to have this opportunity.

Chad Converse:

My experience joining the ROV team has improved my abilities in engineering, science, and teamwork. The team has made me believe in accomplishing goals that I would have never achieved. The opportunity to look at science in a different light has expanded what I want to accomplish in my life, and I want to expand on what I have learned, and bring this knowledge to future generations. I have grown as a person and a mentor. This team has overcome obstacles that at first seemed impossible. I am proud to have been a part of Big island Robotics from the University of Hawaii at Hilo.

Shane Emerson:

Getting to be a part of the Universities first ROV team, and MATES 2011 International Competition has been a great experience for me. I have been given the chance to experience working on a project on a professional level with a team, while still pursuing my degree in college. I have improved many of my skills by working in a professional environment, and learning how to interact with professional people from a variety of backgrounds. By approaching companies and community members for help through this project I have felt more comfortable in public speaking, which is necessary in today's society to be successful in the science field. I have pretty much grown up building things with my hands, so when I heard about this opportunity I wanted to make use of my skills and try to incorporate them into my love for the ocean and its future in scientific research. I would have never imagined this being a possible career path. My mechanical skills have been tested and surpassed through trial and error efforts that have allowed for me to grow, while showing me how to apply them in different situations. By getting the opportunity to go to the Mate International Competition I feel that it will provide me with many new life long memories and experiences, opportunities to introduce myself on a professional level to the science community, and leave me with better skills and a stronger knowledge to make me more marketable in the future of science. I am grateful to have had this opportunity and am excited to see our first year attempt become something greater. I am thankful for this chance and am very excited to see how we prevail, and where the future years will take us as The Big Island Robotics Team.

John Marusek:

After years of tinkering, taking just about anything apart and fixing it, modifying, or improving it, I found the challenge of building an ROV as a perfect way to merge my past careers and love of the ocean and diving together. To design, build, test and perfect each component with available materials has really driven me look deeper into what type of future is available for me. This is something I never considered as a career choice before but now this has turned into a rewarding experience that I hope to pursue in the future.

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