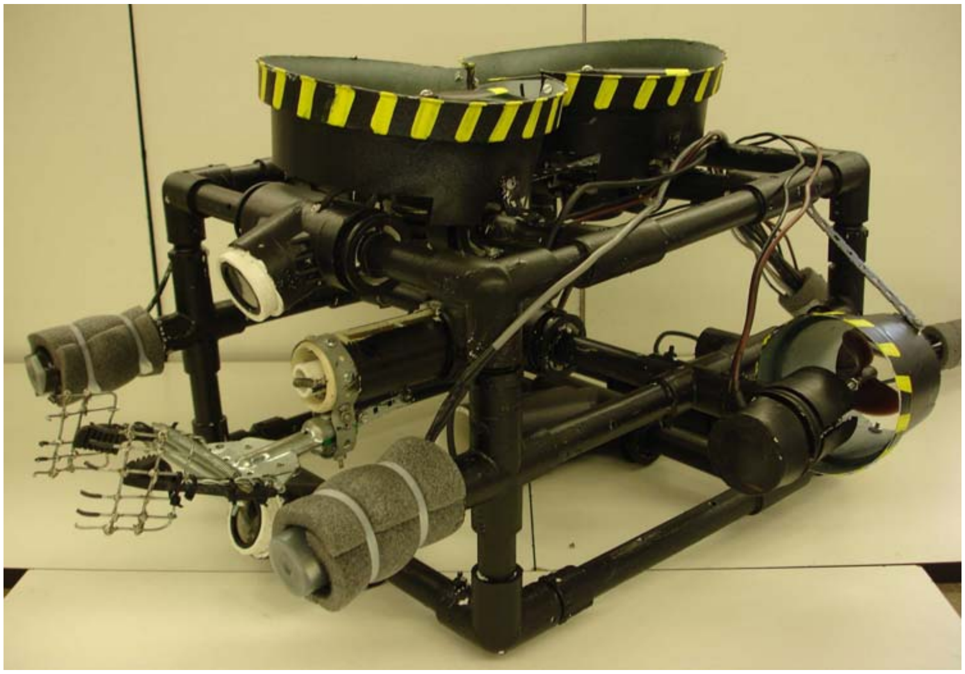
Technical Report



"Bumblebee"
Moanalua High School Robotics Team
Team EPIK

Team Members

Julian Cecil

Angel Diep

Nina Duong

Lauren Mueller

Collin Yabusaki

Derin Young

Instructors:

Mr. Randy Sakauye	Underwater Advisor
Mr. Robert Widhalm	Robotics Advisor

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Abstract

Throughout the 2010 Hawaii Underwater Robotics Competition (HURC) challenges, teams simulate the research of the Lo'ihi seamount by completing four missions. Our ROV, Bumblebee, was built to complete the four missions vital to the exploration of the seamount. The missions include reviving HUGO by detecting the rumbling sites, collecting samples of a newly discovered crustacean, measuring the temperatures of three different locations, and collecting a sample of the bacterial mat.

To accomplish the mission tasks, Team EPIK focused on four main points: simplicity, reliability, maneuverability and visibility. With these four points in mind, Team EPIK created Bumblebee, a neutrally-buoyant ROV with a compact frame structure. Our ROV has five motors, three cameras, and multiple detachable mission tools. Mission tools include a mechanical claw, a hydrophone system, a digital thermometer, and an agar-retrieving device**.**

Our technical report illustrates the technical and structural design of the ROV, along with the challenges we encountered, troubleshooting techniques, future improvement, and acknowledgements. It also includes research of the Lo'ihi seamount, references, and our team member's reflections. Pictures of the ROV, structural parts, mission tools and electrical schematics are also included.

Team Organization

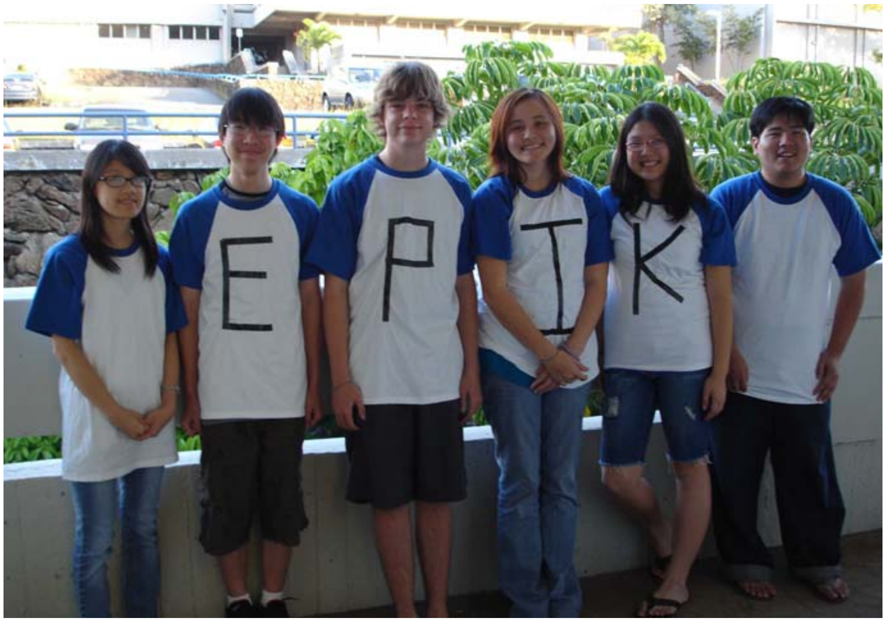


Figure 1: Team Picture (from left to right)
Angel Diep, Derin Young, Julian Cecil, Lauren Mueller, Nina Duong, Collin Yabusaki

This year's HURC team was comprised of both returning members and rookies. Therefore, communication and teamwork were especially important. Each team member was assigned a certain part in the completion of the robot and competition. The three different subgroups were Construction, Electrical, and Documentation. Though each individual was expected to complete their own specific tasks, there were times where we needed to help each other, allowing us to experience all areas encompassed by HURC. This way, we shared new concepts and were able to become more informed about the constant changes made to our ROV.

We named ourselves Team EPIK because it shows our confidence in our ROV. The ROV is named Bumblebee because its colors are similar to those of a bee. If you've watched Transformers, we named our ROV after the main robot character because we want to show that our ROV can accomplish the mission tasks swiftly and in style.

Team Captains
Julian Cecil
Nina Duong

Documentation
Angel Diep

Building
Julian Cecil
Lauren Mueller
Collin Yabusaki

Electrical
Nina Duong
Derin Young

Design Rationale

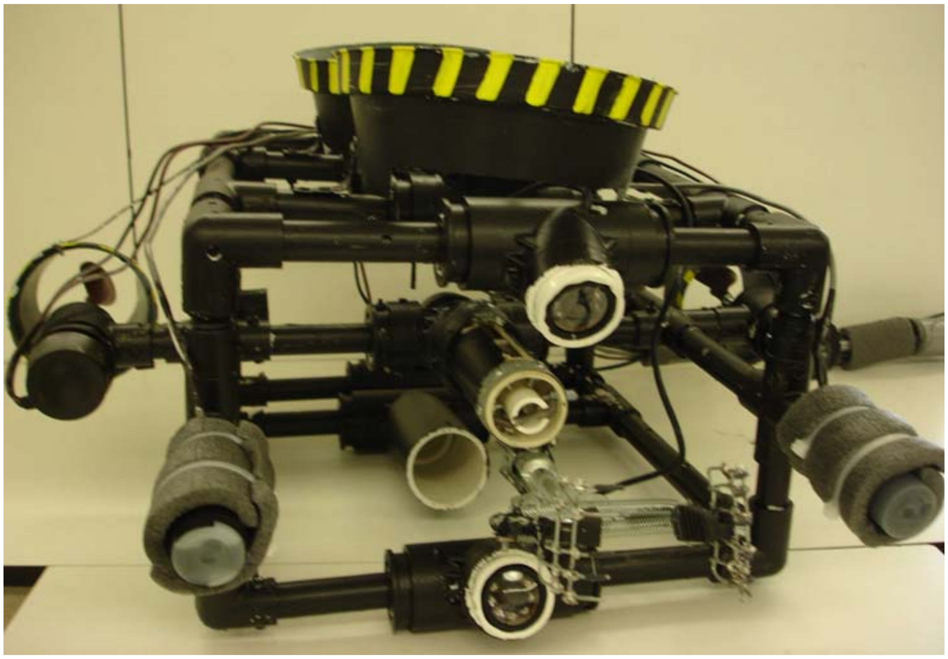


Figure 2: Final ROV

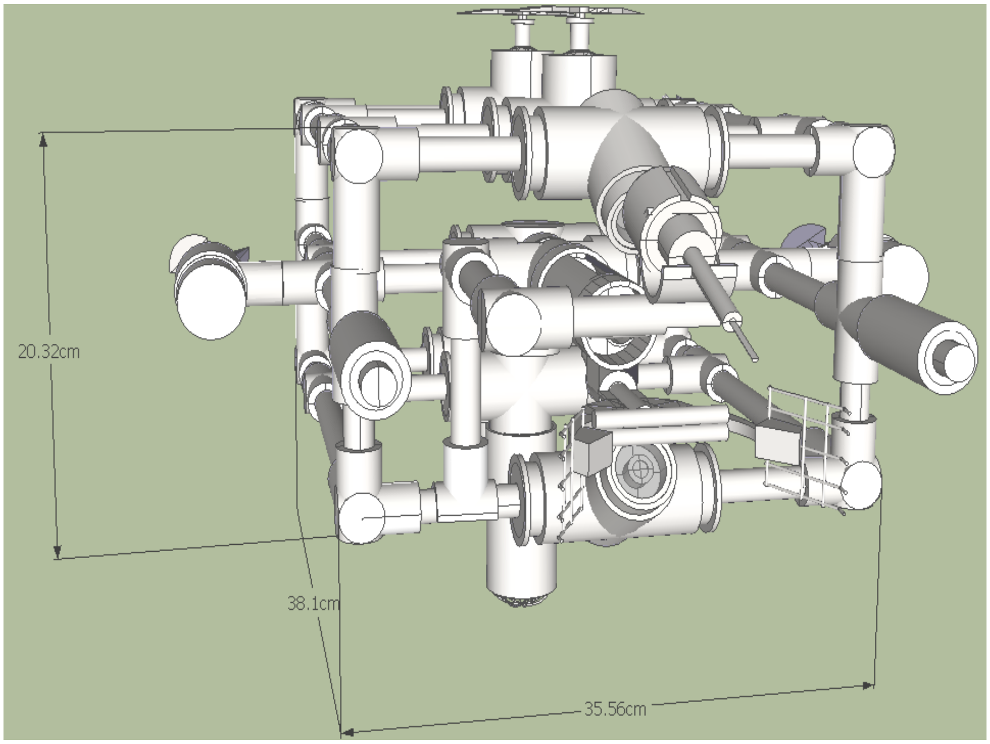


Figure 3: ROV CAD Model

Control System

EPIK elected to adopt a direct manual control system versus a programmable control system. Our rationale can be summarized by the following decision matrix:

<u>Programmable control system:</u>

Is supporting equipment available in Lab inventory?
NO

↓

Is money budgeted to purchase programmable system?
NO

↓

Team has programming skills?
NO

↓

Are there waterproof motors, servos, sensors, etc, available in a Programmable system that is not available in a manual system?
NO

↓

Any other advantages?
NO

<u>Manual Control System:</u>

Is supporting equipment available in Lab inventory?
YES

↓

Is money budgeted to purchase supplemental manual equipment?
YES

↓

Team has electronics skills?
YES

↓

Are there waterproof motors, servos, sensors, etc, available in a manual system that is not available in a programmable system?
NO

↓

Any other advantages?
NO

↓

Decision was made to pursue a direct manual control system based on (1) availability of equipment, (2) costs, and (3) team skills

Frame Construction

Polyvinyl Chloride (PVC) tubes were used as the main building material of the ROV frame because it is lightweight, durable, and easy to assemble. It is easy to assemble due to the wide variety of connector pieces available. Using PVC was also very beneficial because it provided maximum flexibility for structural changes, including the repositioning of motors, cameras, and other tools to maximize operational efficiency. Finally, PVC provides an open frame (38.1 cm x 35.6 cm x 20.32 cm) to optimize control and mobility by creating less water resistance.

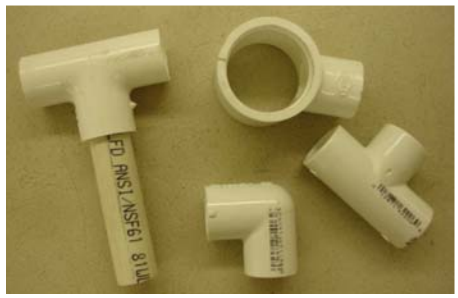


Figure 4: PVC & connector pieces

Buoyancy

The primary goal in building the ROV was to centralize the weight distribution and establish neutral buoyancy at 1.5 meters. Neutral buoyancy is defined as the point in which an object neither floats nor sinks and is reached when the physical mass of the ROV is equal to the mass of the water it displaces.

For consistent ballasting, many holes were drilled into the ROV frame to avoid air pockets and slow leaking. Flexibility was a big consideration for using both fixed and variable buoyancy. Floatation made from boogie board foam represents fixed buoyancy and (three) water bottles were used as variable buoyancy. This way, neutral buoyancy can be reached regardless of the temperature and density of the pool. Such floatation is situated near the top of the ROV, because the floatation will flip the ROV if it is located anywhere else. Pipe insulators were used as floatation for the tether to offset its weight and lessen drag, so the tether does not prove a nuance during the trial.

Tether

The tether is used to transport power to the ROV. The current 12.2 meter tether consists of three CAT-5 Cables, three camera video links, and one hydrophone cable. CAT-5 cables were chosen due to its lightweight and flexible characteristics. In the CAT-5 cable, two 22-gauge wires were doubled up to each motor to provide an equivalent of an 18.5-gauge wire. This minimizes power loss and creates reliability (if one wire were to break, the other can still provide power).

Convenience and efficiency are provided through the organized manner in which the tether is connected. The multiple wires are tied together with zip ties and pieces of floatation (pipe insulation) are added to compensate for tether weight and drag. The

CAT-5 Cables were connected with RJ45 Connecters to ease transportation and facilitate electrical troubleshooting. This means that when the construction group needs to work on the ROV and the electronics group needs to work on the control box, they are able to disconnect the tether and work simultaneously.

As described in the Buoyancy section, pipe insulation is used for tether floatation. With pieces cut at approximately 2.54 cm and evenly spaced out, floatation runs smooth throughout the tether.

Figure 5: Tether

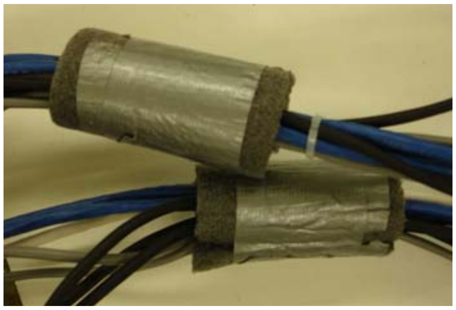


Figure 6: Pipe insulation on tether

Propulsion

SHURflo Aerator Cartridges provide propulsion for Bumblebee. Such motors were selected due to its small size (10.8 cm x 5.7 cm), electrical efficiency, and commercial waterproofing characteristics. Currently, four motors are used to propel our ROV, the fifth for the motorized claw. Each motor is rated to pump 38 liters per minute and together can propel our 7.2 kg ROV at 39.6 cm per sec. Each motor has a low current requirement of 3 amps and are adaptable to Bumblebee's frame (easy to install). Two motors are located at the top of Bumblebee for vertical mobility. The two side motors allow for full-circle rotations. PVC connecters were customized to fit the motors, to allow Team EPIK to mount them in favorable positions.

Based on pool trials, Team EPIK found that a combination of marine propellers for horizontal motion and airplane propellers for vertical motion provide maximum mobility. For safety purposes, side motors are housed in 10 cm nozzles and vertical motors are housed in 20 cm nozzles. Both are made from flower pots.

Figure 7: Side motor with nozzle

Figure 8: Customized PVC piece for motor

Visibility

The black and white cameras selected were chosen because of their high quality video and commercially waterproofed characteristics. Each camera has 9 IR LEDs to operate in environments with poor lighting (cave, etc.) and 420 TV Lines (TVL), which provides a high resolution visual. The cameras are rated to operate as deep as 30 meters. Finally, these cameras are lightweight, small (3.8 cm x 5.1 cm), and require low operating currents making them ideal for use with our ROV. The cameras require ½ amps and therefore, are connected to 1 amp fuses.

Three cameras were secured in various places on the ROV, which provides multiple perspectives and depth perception. There are two cameras located at the front of the ROV for navigational purposes (if one camera fails, the other camera is available for use). The last camera is located at the very end of the ROV and can be angled down to focus on the agar-retrieving device. For each and every mission, at least two cameras can be moved to view the specific mission tool.

Figure 9: Front camera secured in PVC connector

Safety Features

To ensure the safety of the members of Team EPIK, as well as the ROV, flower pots were used as propeller guards. This cautioned and prevented anyone from coming into contact with the propellers when the motors are on. Propeller guards are painted with alternating yellow and black stripes to signify such caution.

In addition to propeller guards, duct/electrical tape covered zip ties to avoid inadvertent personal injury.

Figure 10: Propeller guards with safety designation

Mission Specific Apparatus

Specific apparatus pieces were created for individual missions. A versatile claw is required in three different mission tasks. This specific claw was redesigned from a commercial, hand operated grabber. We redesigned this device so that it can be controlled by a SHURflo motor. Team EPIK threaded a rod and screw drive to transform it into a mechanized claw, controlled through a double pull double throw (DPDT) switch. After numerous lab and pool tests, we found ways to further optimize its performance by adding metal “teeth” to improve the grip of the claw and by making structural changes to improve the its operational reliability.

To detect the rumbling sites (Task #1), Team EPIK constructed a stereo hydrophone system (based on the recommendation provided my MATE) from a microphone condenser, audio cable, mini amplifier, and headphones. The waterproofed microphone portion of the hydrophone is situated near the front of the ROV and padded to minimize ambient noise and maximize forward sound detection. The stereo effect will enhance the sensitivity to direction of the noise sources.

The thermometer tool (Task #3) is placed in the front as well. Team EPIK chose to purchase a commercially waterproofed digital thermometer because of its accuracy, quality, and self-contained convenience. The thermometer is attached an arm, which consists of a flashlight and a sun shield to maximize visibility, especially in dark areas.

Team EPIK created the agar-retriever (Task #4). As its name suggest, the agar-retriever consists of a PVC core and a wired insert to hold the bacterial mat within. This design was selected for its simplicity. The ROV must only use its vertical motion to push the insert into the core to simultaneously collect the agar.

Figure 11: Motorized claw

Figure 12: Addition of metal “teeth”

Figure 13: Thermometer

Figure 14: Agar-retriever

Figure 15: Hydrophone system

Control System

Three joysticks are utilized for controlling the ROV motors. One joystick is used to control the vertical movements, via arcade drive. The other two joysticks are for horizontal movement, via tank drive. Team EPIK chose this combination of controls, so that vertical and horizontal movement can be achieved at the same time. Each motor is connected to a 4 amp fuse, to protect the ROV in case of any short circuiting. As stated before, two 22-gauge wires are combined to provide an equivalent of an 18.5 gauge wire. This minimizes power loss and provides redundancy reliability, should one wire get damaged. Finally, a connector is used to allow voltage through the vertical and horizontal joysticks. Also, RJ 45 connectors are used to connect the tether to the control system. The use of such connectors facilitate isolation and in turn, troubleshooting.

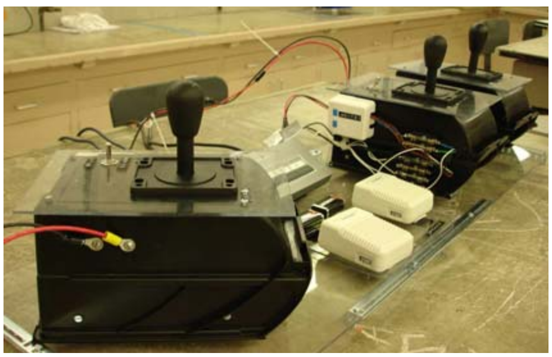
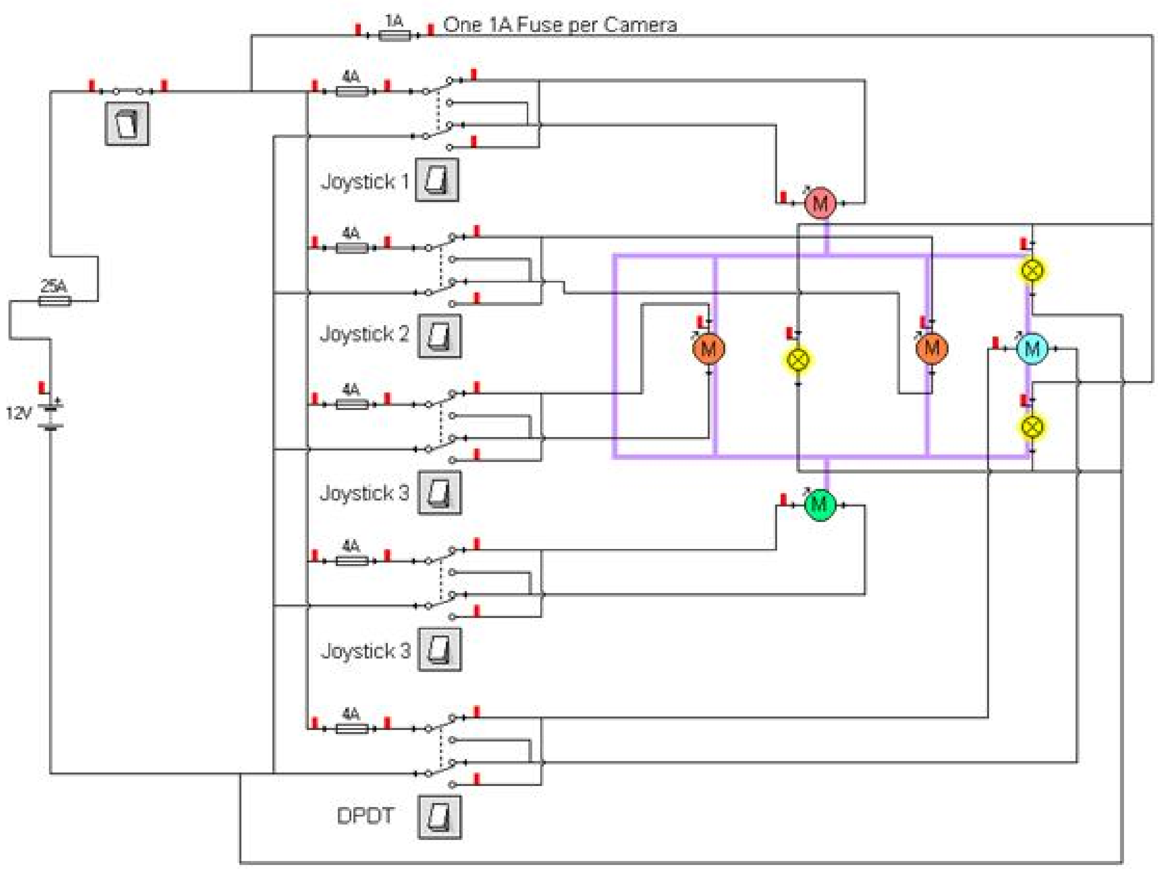


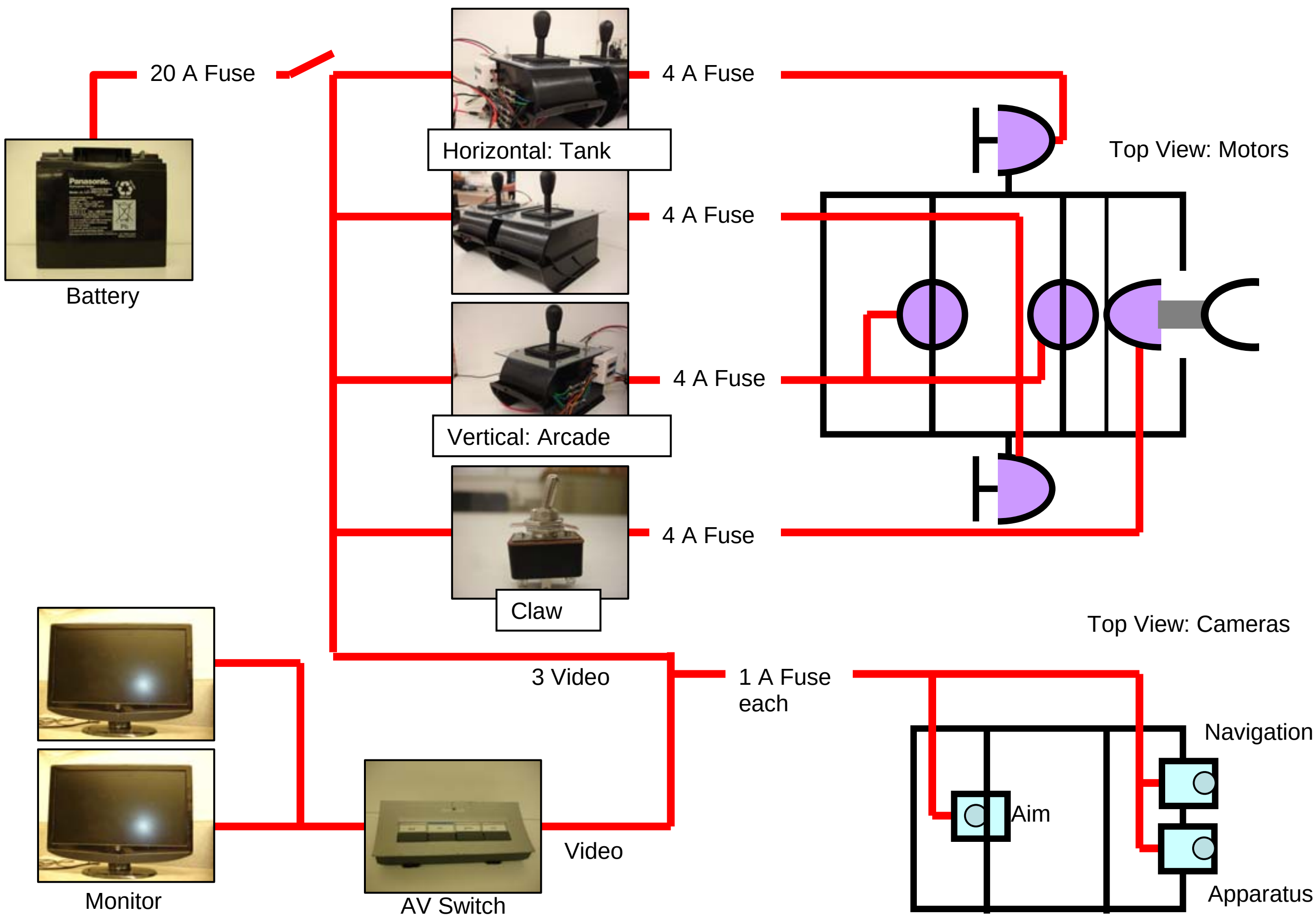
Figure 16: Control System

Figure 17: Hydrophone system speakers

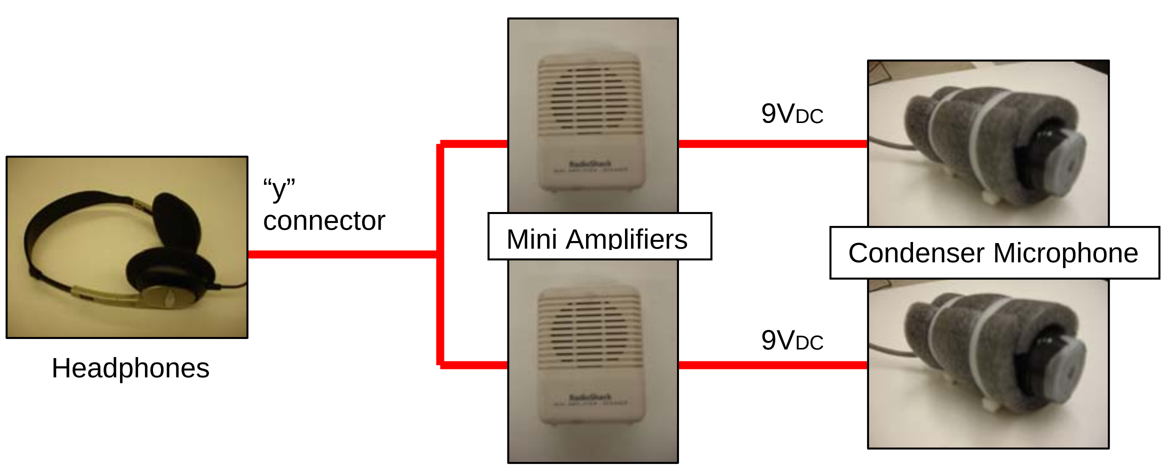
Electrical Schematics



Block Diagram



Stereo Hydrophone System



Total Electrical Load

The total peak load on the 12V battery can be summarized as follows:

Components	Units	Total amps
Motors	5	15 amps
Black & White Cameras	3	1.5 amps
	Total peak current requirements	19.5 amps

Other instruments (i.e., the Hydrophone system and Temperature gauge are self-contained using their own batteries per the MATE guidelines).

Challenges

The challenges that we encountered were not only technical, but involved human relations as well. As with every year, there are many people who sign up for HURC, but it always comes down to only the people who really want to contribute their effort and time. This year, we have experienced members from last year and a couple of new members.

One of the main challenges that many of our group members came across was the amount of effort put in by each member. Consequently, some members were less active while others were more active.

Although we started off strong with a working prototype to test with, a few members were very busy with other extracurricular projects: other robotics competitions as well as academic commitments. Although it was difficult for the whole team to work together at the same time, we didn't let it stop us. While some contributed more than others, we were still able to reach our goal.

Another challenge we encountered was that because marine technology is expensive and limited, we needed to come up with techniques to waterproof certain mission tools. Unfortunately, we were not always successful and damaged some equipment while pool testing.

Troubleshooting

Organization was the key troubleshooting technique that we used. Wires were labeled and color-coded, allowing Team EPIK to easily trace specific wires. This not only allowed for the immediate detection of loose wires and/or other electrical problems, but also eased the rewiring of selected circuits without disrupting the wiring of other circuits within the control box. In regards to disconnected wires, we chose to double our wiring; instead of just relying on one wire, we have two, in case the other breaks. As for short circuits, fuses were connected to both motors and cameras. The amount of time spent on the rewiring of the entire tether was significantly decreased.

Two specific isolation tools were used. One was the utilization of two RJ45 connector boxes. Each CAT-5 cable was attached to a RJ45 connector, at the control box. We could easily disable selected circuits and/or detach the tether from the control unit to troubleshoot separately. This isolation allowed us to use the multimeter, checking for continuity to detect short-circuits or wire disconnections. This also allowed for ease of movement, since the control unit didn't necessarily need to be where the ROV was. The second isolation tool was the use of a connector for the positive and negative leads between the horizontal and the vertical joysticks. We are able to detach the horizontal from the vertical joystick, allowing us to further isolate connections and detect problems when they arise.

Lastly, an open architecture frame was utilized to allow for visibility, access and troubleshooting of each ROV apparatus. Everything attached to Bumblebee is readily visible and available, allowing for immediate change in position and/or isolation as necessary.

Future Improvements

After all the challenges Team EPIK has gone through, we all acknowledge that we could have improved our communications and teamwork. A more disciplined organization and interactive goal discussions and settings would have streamlined our research, build-out, and testing efforts. This experience will be valuable as we finalize Bumblebee and share with future teams.

From a design perspective, we would opt to improve two of our mission tools: the unit that reads vent temperatures and the apparatus for capturing cave samples. Due to time constraints, we did a hasty job of researching temperature gauges and found ourselves with waterproofing problems and marginal ability to read the gauge, making this unit less than ideal. Likewise, our solution for capturing cave samples was compromised in that while our "claw" is an excellent device to grab the sample, we did not have an effective means to store multiple samples. These are two areas that we hope to rectify prior to the International competition.

Reflections

I was able to apply the skills that I learned from the last two years of my experience in HURC to this year's competition. Some of these skills that I used were designing a good frame for the ROV and coming up with ideas for certain mission tool. For next years competition, if I do decide to join, I will try to improve on teaching the new people how to use the power tools and encourage them to help come up with ROV designs.

-Collin Y.

I think that HURC was a pretty good experience for me. Learning about the various tasks that the ROV had to accomplish was interesting and showed the intricacy required in making a robot for underwater exploration. While the robot itself is complex, many of the parts and mechanisms on the ROV need to be versatile and multi-functional allowing the robot to stay underwater for longer periods of time and complete more than one task each journey down so it doesn't need to go back to the surface to be refitted with new equipment after each task. Because of this, some parts are more effective with simpler designs and requirements so they do not weigh the ROV down or need unnecessary electronics on it.

- Derin Y.

This year was the most I've ever done in terms of electronics. I've been in HURC for the past two years and I've recognized the aspects of the control system that I had to be weary about. I had to know things like permanent connectivity, insulation, and isolation between parts. It was so much work, and often times, I was frustrated because the outcome wasn't the perfection that I had imagined. This control system has had major surgery only once, and hopefully, that will be the last.

I'm currently taking an Electronics class, and I was able to relate concepts that I learned in class, with that of the control system. Much of it was the simple "closed circuit equals working circuit" type of relationship, but it was definitely rewarding, seeing the ROV move the way it was meant to move, through the control system.

- Nina D.

This is my second year as a HURC participant and I was more familiar with what was expected to be on the technical report. I felt that this year it was harder to focus on HURC with other extra curricular activities and competitions. Instead of always gluing my face to the computer screen while writing this, I wanted to participate on other aspects in the building of the ROV and I did. However, I did gain a lot from writing the technical report. I learned about what we used to build the robot with, why we chose the methods we chose, and how everything just ties in together. I'm looking forward to next year's underwater robotics competition already.

- Angel D.

As captain this year, I've found that this year was more challenging than the competition last year. Nonetheless, I found, as my duty as team captain, that ordering people around won't work in getting us all the way to the international competition. We all didn't want to see our hard work, time and effort go to waste, and my duty as captain was to push them toward success. I am proud to be part of this team and I'm glad that I got to experience this challenge this year, so that I know what I need to do next year.

- Julian C.

Research – Lo’ihi Seamount

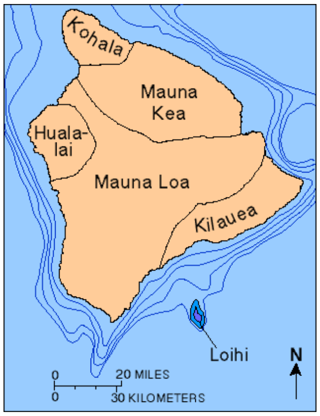


Figure #: Location of Lo’ihi

The Lo’ihi Seamount is the youngest active volcano, less than 1,000 years old. The seamount is located about 30 km south of Kilauea which is a part of the Island of Hawaii. Lo’ihi’s summit averages about 1,000 meters beneath the surface of the ocean and stands at 3,500 meters above the sea floor. Its name, “Lo’ihi,” was introduced in 1955 and adequately describes the seamount’s “long,” elongated shape.

There are many interesting creatures that inhabit Lo’ihi, including the copious shrimp that graze on bacterial mats. A particularly interesting creature is a type of octopus that measures 4 to 6 ft (1.22 to 1.83 m) in diameter and have 4 in (10.16 cm) spikes instead of suckers. Another unusual sea creature is an off-white-colored angler fish. This fish actually has four legs and uses them to sit on rocks.

The Lo’ihi Seamount was created when lava leaked from the same hotspot that created the Hawaiian Islands. The lava that reaches the surface cools and hardens before the next layer forms above it, thus the formation of the seamount. This process is the same one that formed the rest of the Hawaiian Islands.

In 1955, Kenneth O. Emery discovered an unusual patch of water where radio signals bounced off of a bump in the seafloor near Mauna Loa. It wasn’t until the seismic activity in 1972 and 1975 (detected by the Hawaiian Volcano Observatory) that Fred W. Klein verified that the bump was, in fact, an active underwater volcano.

During July thru August of 1996, Lo’ihi became the site of major seismic activity. More than 4,000 earthquakes were observed by the Hawaii Volcano Observatory’s seismometer grid. Lo’ihi’s volcanic eruptions and collapses caused an increase in carbon dioxide emissions, generated tsunamis, and destructed biota. A quick response cruise was then created and funded by the National Science Foundation to respond to events of this nature.


Figure #: Pisces V

After the 1996 event, *Pisces V*, a three-person, battery-powered submersible, was launched, to allow scientists to observe the deep sea. Specifically, scientists were able to acquire new information regarding the Lo’ihi seamount by taking photographs and video clips via *Pisces V*. This submersible can also collect samples and place instruments for further observations. When *Pisces V* submerged to gather data on Lo’ihi, the water was murky and bacterial mats were scattered around the area.

This year’s competition theme reflects the research and discoveries made by real scientists and researchers via submersibles, only on a smaller scale. Throughout the season, Team EPIK needed to utilize the same skills–creativity, perseverance, innovation–that allowed for the discoveries that real scientists make about the Lo'ihi Seamount.

Budget

The budget for 2010 was set at $600. Unfortunately, due to unanticipated equipment requirements to fulfill the missions, higher general costs (inflation) and water damage, we exceeded budget by 35 %. Funds were predominately provided by a Federal Grant (Perkins) and ROV costs are summarized as follows:

Description	Unit Measurement	# of Units	Unit Cost*	Subtotal	Cumulative Balance
½" PVC	Linear CM	275.5	$0.008	$2.26	$2.26
½" PVC 3-way 90 deg	# Conn	8	$1.75	$14.00	$16.26
½" PVC T-conn.	# Conn	12	$0.40	$4.80	$21.06
1 ¼" x ½" T-conn.	# Conn	2	$1.50	$3.00	$24.06
1 ¼" PVC T-conn.	# Conn	8	$1.40	$11.20	$35.26
½" PVC L-conn	# Conn	2	$0.50	$1.00	$36.26
½" PVC Cap	# Conn	14	$0.39	$5.46	$41.72
Underwater Camera	# Cameras	3	$90.00	$270.00	$311.72
Piranha motors	# Motors	5	$42.00	$210.00	$521.72
Arcade Joysticks	# Joysticks	3	$10.95	$32.85	$554.57
Marine Propellers	# Propellers	2	$1.65	$3.30	$557.87
Air Propellers	# Propellers	2	$2.13	$4.26	$562.13
233.52 cm Metal Strip	Linear CM	24	$0.007	$0.17	$562.30
Stem Conn (for props)	# Conn	5	$1.50	$7.50	$569.80
CAT 5 Cable (Tether)	Linear meters	40	$0.48	$19.20	$589.00
25 Amp Fuses	# Fuses	1	$0.80	$0.80	$589.80
4 Amp Fuses	# Fuses	5	$1.00	$5.00	$594.80
RCA 182.88 cm Cable	# Cables	3	$3.95	$11.85	$606.65
Banana Conn	# Conn	2	$0.45	$0.90	$607.55
Power Switch	# Switches	1	$4.00	$4.00	$611.55
RJ45Connector	# Conn	3	$0.50	$1.50	$613.05
BNC/RCA Adapter	# Adapters	3	$2.50	$7.50	$620.55
7.62 cm x 10.16 cm Bins	# Bins	3	$2.24	$6.72	$627.27
Assorted Cable Ties	# Ties	55	$0.02	$1.10	$628.37
Assorted screws/nuts	# Screws/nuts	35	$0.03	$1.05	$629.42
Water Bottles	# bottles	3	$0.05	$0.15	$629.57
Floatation Material	# cubic CM	725	$0.02	$14.50	$644.07
Hydrophone Amplifier	#Amplifiers	2	$17.99	$35.98	$680.05
Hydrophone Audio Cable	#50' Cables	2	$11.98	$23.96	$704.01
Hydrophone Earphones	#Earphones	1	$9.99	$9.99	$714.00
Hydrophone Y conn	#Y conn	1	$5.69	$5.69	$719.69
Waterproof Temp gauge	#Gauges	1	$31.95	$31.95	$751.64
Film Containers**	#containers	2	$0.40	$0.80	$752.44

Mono Jacks	**#Jacks**	**2**	**$4.29**	**$8.58**	**$760.22**
Temp Gauge* **	**#Gauges**	**1**	**$31.95**	**$31.95**	**$792.17**
Personal Sound Amplifier* **	**#Amplifiers**	**1**	**$29.95**	**$29.95**	**$822.12**

* Unit Costs - Approximately 50% of equipment was already in Lab stock. Even so, all costs were calculated as if purchased new and prorated (by units) accordingly.

** Donated items- 3 Film containers from Longs Drugs

*** R/D Items - Items purchased but failed to perform as needed or suffered water damage.

References

Lo’ihi Seamount and history:

Riley, Jeannie. "Lo'ihi Seamount." Mb *University of Arizona, Department of Geosciences*. Web. 26 May 2010. <http://www.geo.arizona.edu/geo5xx/geos577/projects/riley/Lo’ihi Seamount Web Page.htm>.

"HURL Current Research: Lo’ihi." *SOEST | School of Ocean and Earth Science and Technology*. University of Hawaii: School of Ocean and Earth, Science and Technology. Web. 26 May 2010. <http://www.soest.hawaii.edu/HURL/hurl_Lo’ihi.html>.

"Lo`ihi Seamount, Hawai`i's Youngest Submarine Volcano." *USGS Hawaiian Volcano Observatory (HVO)*. USGS. Web. 26 May 2010. <http://hvo.wr.usgs.gov/volcanoes/Lo’ihi/>.

Tominaga, Lance. "Lo'ihi - Hawaii's Coming Attraction." *Coffee Times*. LBD Coffee LLC. Web. 26 May 2010. <http://www.coffeetimes.com/Lo’ihi.htm>.

Life on Lo’ihi:

"Marine Scientists Return From Expedition to Erupting Undersea Volcano." *The National Science Foundation*. The National Science Foundation, 5 May 2009. Web. 26 May 2010. <http://www.nsf.gov/news/news_summ.jsp?cntn_id=114717>.

Pisces V:

"Pisces V Specifications." *Hawaii Undersea Research Laboratory*. University of Hawaii: School of Ocean and Earth, Science and Technology. Web. 26 May 2010. <http://www.soest.hawaii.edu/HURL/pisces_V_specs.html>.

"The Pisces V and Pisces IV." *NOAA Ocean Explorer*. NOAA, Office of Ocean Exploration and Research, 2 Mar. 2006. Web. 26 May 2010. <http://oceanexplorer.noaa.gov/technology/subs/pisces/pisces.html>.

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- Mr. and Mrs. Higa
  For allowing us to use their private pool for our excessive pool testing trials.

- MATE Center
  For giving us an intellectual and unique challenge that stimulated our thinking.

- University of Hawaii
  For being the primary sponsor for HURC Regional event.

- Pearl Harbor Naval Station
  For being able to provide Richardson Pool for the Regional Competition.

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