Galatea ROV

Langley High School

Team

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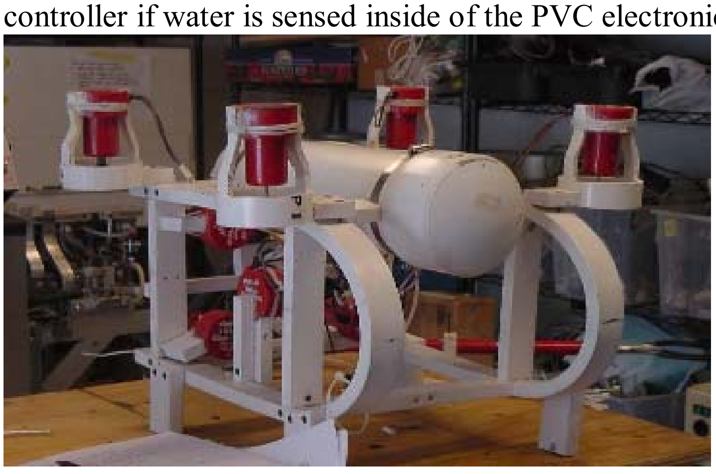
Abstract

The Langley High School team's goal this year was to construct a Remotely Operated Vehicle, which is adaptable, versatile, and maneuverable enough to complete the difficult challenges mandated in this year's Ranger competition class. A major factor for the Langley High School student body in participating in the ROV Competition was that we wanted to do something new and exciting, and we hoped that with we could snag the technical interest of students with the awareness raised for the Galatea team. During the design stage of Galatea, great consideration was taken over this year's task. The decisions made on the materials and technologies used on the submersible were heavily influenced by two main aspects: the cost effectiveness and the simplicity by witch the tasks could be completed. The team hopes that its dedication and man hours will not be in vain. Galatea will live up to our high standards and expectations with its numerous innovations and conquered challenges. Though our finished product does make use of PVC, our frame is made of a flexible, plastic, house siding, which, given its unique properties is more suitable to our needs than PVC. Both missions will test the ultimate capabilities of our teamwork, engineering, and electrical design skills. Though our team is partly dissipating, the remaining members have redoubled their efforts to complete our competition package in time. The name for our ROV was inspired by a Nereid of Greek mythology, and the team believed it fitting for the ROV's marine purposes.

Design Rationale

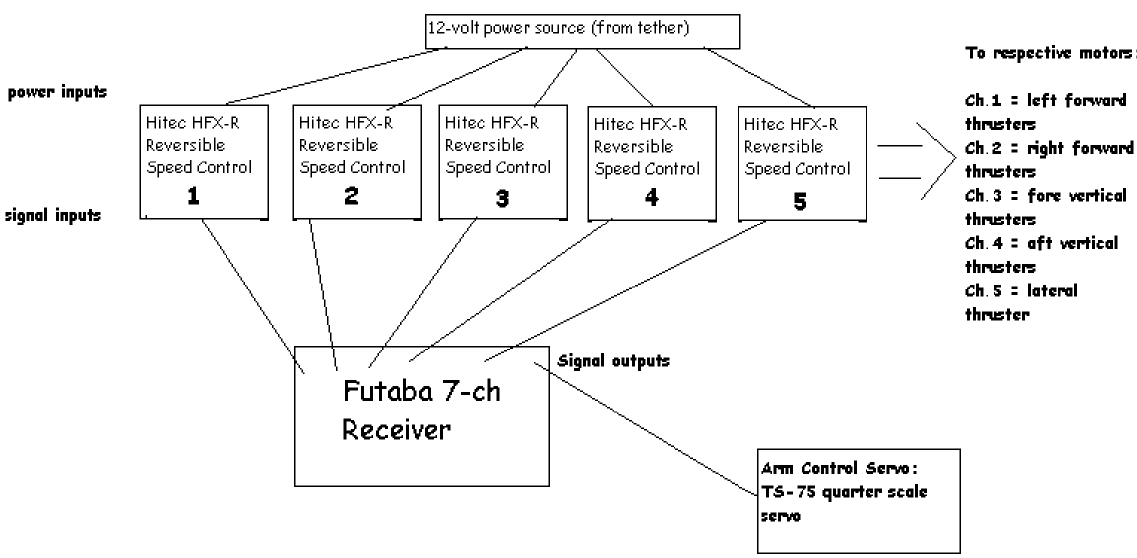
Given our limited resources, the team relied on many donated or recycled materials, a concept we supported from the very beginning. Our frame is comprised of two geometric shapes, a cube and semi-cylinder mounted forward. The frame is composed of a flexible plastic, house siding, which was unique to our design up until recently when it was discovered by other competitors at a national meeting. It has a lesser density than water and its limited buoyancy helps the ROV to be almost perfectly neutrally buoyant; a feat that took us a long time to attain. The shape is that of many industrial ROV's; we believe it is well-suited because the cylindrical front end serves as a hydrodynamic bumper as well as a floatation device, in case we pick up a heavier object with our protruding claw. The whole robot was designed to fit in a 50.8 x 50.8 x 50.8 cm cube. Although it is one of the smaller robots in the competition, this size allows the Galatea to be more maneuverable. That, coupled with the 9 thrusters totaling 250 watts of power, should give us an edge in handling. The frame encases all seven thrusters, the claw, a release servo, three video cameras, as well as the PVC pipe which contains our speed controllers and electronics. The speed controllers are infinitely variable; this is a critical aspect of the ROV especially when adjusting the pitch of the submersible. The tether, which is attached at the rear end of the ROV, is a twelve wire package including a coaxial central signal cable. The Kevlar reinforced, polyurethane coated tether is thirty feet long and was donated to the Langley ROV Team by South Bay Cable Co. A water sensing device was home built and placed inside the electronics housing. Nicknamed the "Oh Crap" sensor, it transmits a signal to the controller if water is sensed inside of the PVC electronics housing.

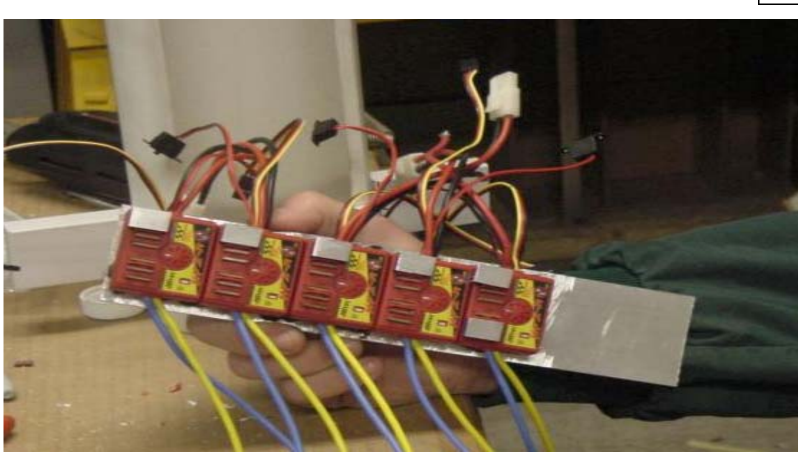


Galatea controls

Galatea is controlled by a Futaba 7 CAP/ 7CHP selectable 75 MHz band remote control, which was originally intended for use on flying model airplanes. With some slight reprogramming, each of the seven channels is being utilized. One channel each for the left- and right- aft mounted thrusters, one channel for each vertical thruster, and one channel controlling the side-to-side thruster; this combination makes use of the remote control optimally. Additionally, the payload release mechanism located on the bottom of the Galateais activated by a remote controlled on/off switch.

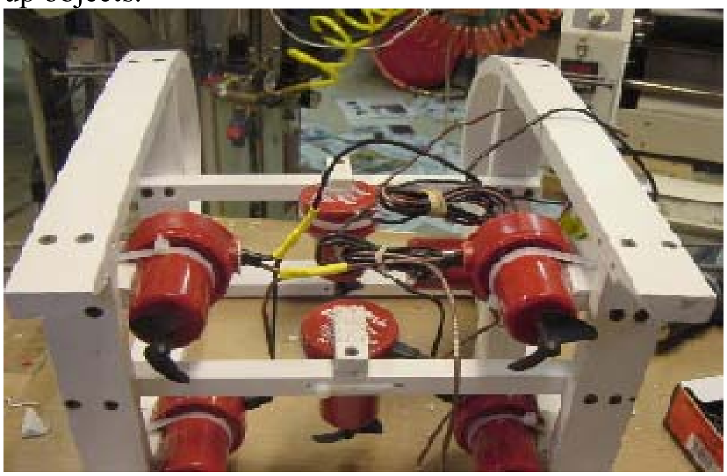
ROV on-board Wiring Diagram:





Motors

The Galatea is driven by nine modified 800 to 1100 GPH bilge pumps, which are fully reversible. Four thrusters are mounted on the rear of the frame. They control forward, backward, and rotational motion. An additional four thrusters are placed in directional safety mounts on the dorsal side of the ROV. These thrusters control the pitch and altitude of the Galatea. A final thruster is mounted on the side of the Galatea, and it provides horizontal thrust, that is used for fine adjustment when aligning the claw to pick up objects.



Cameras

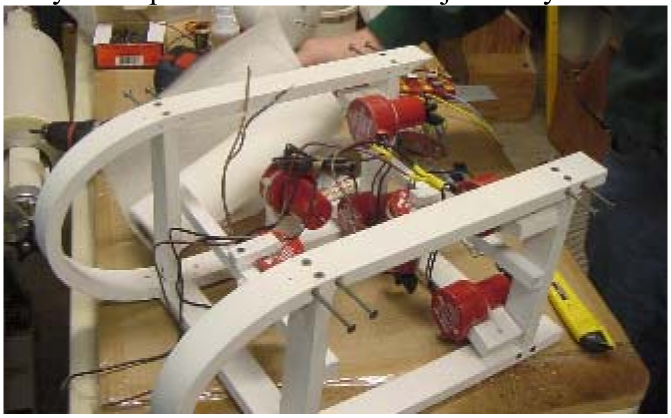
There are three cameras incorporated into our unit. All three of these cameras are color Sony CCD Bullet cameras. They each have been placed in a waterproof PVC housing. One is located near the release servo, pointing down as to give good visibility of the bottom of the seafloor. In the mission's case, it is used to align the electronics module and prepare it for release. The other is mounted at an angle pointing towards the front of the claw. In unison with our third camera, this one will provide our navigator with enhanced depth perception. The final Bullet camera is mounted on our robotic claw, and will be the main navigating tool as it faces the direction in which the Galatea travels.

Robotic claw

The robotic arm was built from a modified trash pick-up tool. A quarter-scale RC servo with 8.42 kg/cm of torque was placed on the end of it to activate the pull-mechanism of the arm. It can lift up to a five-pound object off of the sea floor.

Ballast

The ballast on the Galatea is fixed; the submersible is set up to be as close to neutrally buoyant as possible. Altitude is adjusted by the vertical thrusters.



Challenges

From the first mention of the competition by our science teacher, there was an interest in joining the team for this year's competition. Numerous people signed up for the team and were all prepared to put in their share of work. Unfortunately, unbeknownst to either us or our teacher, the rules for this year required us to attend a regional competition in Norfolk, Va. Although this was not LHS first year competing, LHS had always proceeded directly to the National competition held later in the year in Houston. The news that we had to attend the regional competition came as a surprise, and immediately the problems began. Some people left the team, as the dates coincided with the start of LHS spring break, and many had already made plans long before the news of this competition came up. The unexpected dates already provided us difficulties in procuring materials and equipment. Various companies and persons had promised to support the project, but unfortunately not all could deliver within the short time frame. As a result, the few remaining active members scrambled to begin work on the machine, and pulled a few all-nighters in order to patch together a technical report and a team poster. Another challenge is the lack of team members who will participate in the contest, as all but two are scheduled to be absent during the first weekend of spring break. Hopefully that pair can manage and with good fortune secure a place at the International competition, where the rest of the team will be ready and waiting to do their part.

Troubleshooting techniques

Usually we started working on all of our problems by assuming that the simplest things went wrong first. There were lots of small wiring issues, and most of them were fixed by tracing down bad connections with a multimeter. Another technique: not freaking out. Most of the time, failure is not to be blamed on failing electronic components; most of the problems are caused by the way that they are set up or wired.


Figure 1 Max fine-tuning the PVC pipe

Lessons learned

Keep your teammates informed and up-to-date on all the latest developments, especially if the ROV is being worked on alone or without all teammates present

Let your instructors know how the project is coming along, or they will stop believing the ROV is actually being worked on.

Assign tasks early and divide the tasks according to everyone's strengths

Troubleshooting

When maneuvering Galatea during practice runs carrying a payload, we encountered some trouble in maneuvering the ROV vertically. As a result, the team decided to add two additional vertical thrusters, of the same type as the other thrusters.

Another problem arose when we discovered the cameras that were thought to be waterproof began to let in water. At that point we decided if we wanted the cameras to work reliably, we exchanged the "Chicago "underwater cameras with two Sony bullet cams, which we personally waterproofed and tested. We also ended up having an extra camera, which we could install to replace a malfunctioning one.

In order to ensure the safety of those who might approach Galatea, we placed safety rings around each of the bilge pumps, and labeled them as dangerous to the touch.

In an effort to reduce drag, the horizontal bar at the front of Galatea was removed, and our team spent a good deal of time buffing out scratches and scuffs, and also patching gaps that could possibly affect the performance of Galatea.

We adjusted the vertical and horizontal thrusters of Galatea to counter-rotate, which cancels out any involuntary movement caused by the torque of the propellers.

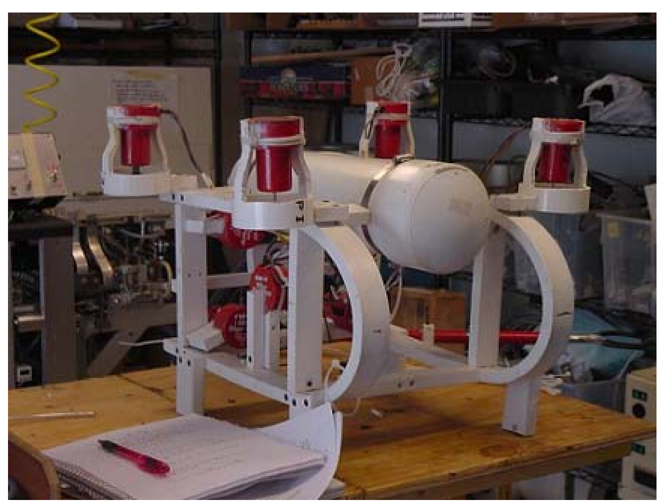
Figure 2 Our self-constructed practice container

The Pacific Coast Ocean Observing System (PaCOOS)

As an immediate need to measure the effects of man's activities on marine environments and to forecast the effects of ecosystem fluctuations on the products, services and benefits we derive from the ocean arises, groups such as the NOAA, academic partners, foundations, state fisheries agencies, and other organizations are developing an integrated Pacific Coast Ocean Observing System, which is focused on the California Current ecosystem. PaCOOS will hopefully provide information needed for the efficient management of fishing resources, endangered and protected marine mammals, marine birds, and marine turtles, and to predict the consequences of fishery removals and climate change. Back in 2002, foundations, scientist, university professors and marine agencies participated in the "Alliance for California Current Ecosystem Observation", or ACCEO for short. It consisted of a series of meetings held in Monterey, California, Seattle Washington, and Portland, Oregon. Their goal was to develop a practical means of physical and biological marine observation that would increase the manageability of natural resources and facilitate the assessment of climate change on California's Large Marine Ecosystem.
Then, in 2003 the ACCEO concept was renamed, and given a broader role, in being chosen as the NOAA's west coast branch of national Integrated Ocean Observing System, or IOOS. From then on it has been known as the "Pacific Coast Ocean Observing System", "PaCOOS".

Sources: http://www.pacoos.org/default.htm
http://marinemetadata.org/examples/mmihostedwork/ontologieswork/mmiworkshop05/domains/pacoos11

A look at a complete "Gally"



Capital Equipment List

Hobby-related items bought from www.towerhobbies.com:

APC 4.2x2 Sport Propeller	2	3.50		
Astro Flight Prop Drive 020/035 1/8" Shaft	1	4.95		
Hitec HFX-R Speed Control Reverse	1	58.99		
Venom Fireball 13T Double Motor	1	15.99		
APC 7x8 Sport Propeller	2	3.50		
Tower Hobbies 7-Cell 8.4V 1900mAh Flat Standard NiCd	1	18.99		
APC 7x4 15 Free Flight	2	3.50		
APC 9x4 Sport Propeller	2	4.38		
HPI Silicone O-Ring	1	1.90		
Great Planes ElectriFly Pinion Gear 12T 3.8:1	1	3.79		
HPI Silicone O-Ring P-3 Red	1	1.45		
DuraTrax Powerpole Connector (20)	1	13.99		
Traxxas Propeller Left 4.0mm Villain EX	3	8.67		
Great Planes ElectriFly GD-600 Elec Gear Drive 2.5:1	1	12.99		
Traxxas Propeller Right 4.0mm Villain EX	3	8.67		
Hitec HFX-R Speed Control Reverse	4	235.96		
Dubro Heat Shrink Tubing 3x3/16" (3)	2	2.78		
Dubro Assorted Heat Shrink Tubing (12)	1	4.59		
Tower Hobbies TS-75 Servo S3K 1/4 Scale U	1	34.99		
Dubro Waterproof Pushrod Seals (2)	1	3.59		
Hitec Spectra Synthesized Tx Module Hitec Prism	1	74.99		
Tower Hobbies TS-75 Servo S3K 1/4 Scale U	1	34.99		

Total Tower Hobbies Order: $873.71

Items bought from other sources.

- 5 bilge pumps (4 were left over from the previous year) $175
- Flexible House siding from the Home Depot $85
- PVC Cement –Home Depot $5
- 10’ of 4” PVC Piping- Home Depot $14
- PVC endcaps and rubber fittings - Home Depot $30
- Clear plastic tubing (40’) - Home Depot $20
- 3 boxes of wood screws, used on house siding- Home Depot $15
- 2 underwater cameras from Harbor Freight Tools $200
- 2 underwater Sony Bullet Cameras from Ebay.com $150

GRAND TOTAL: $1567.71

Galatea and the future?

In the event that Langley High School will be competing in this competition next year, they will invariably attend with an upgraded Galatea. While we have a suitable material for an ROV, its plain white color is not as striking as it ought to be, so for one Langley will hopefully have a more decorated Galatea, with an improved and more complex robotic arm mechanism, which will have more function than just being able to complete the tasks laid before us in this year's competition.