ROV MARCUS

Notre Dame Preparatory School
Marine Science Class

MATE National ROV Competition
2005

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Team Mentors:
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ABSTRACT

The Notre Dame Preparatory School marine science class constructed the ROV "Marcus". Approximately fifteen girls came together to build Marcus, which would later compete in the Marine Advanced Technology Education (MATE) National ROV Championships. This year the 2005 MATE ROV Competition will be held at the Neutral Buoyancy Laboratory at NASA Johnson Space Center in Houston, Texas from June 17th to June 19th. The team is composed of both juniors and seniors that have no experience in the field of robotics. The girls were willing to participate even though they knew the competition would be tough. The team went through various designs, finally producing a box shaped base made out of PVC piping. Along with the box frame, the team decided upon a jointed arm with a rotating hand. Many other low cost components were used to aid in the building of Marcus. Though the team encountered various difficulties and technical problems, the end result was all worth it. The team has spent many weekends working on the ROV, which hopefully will work well in the competition. Everyone is getting excited and hopefully it will be a great competition between all teams.

Design Rationale

The ROV was designed as a cubic structure with four propellers, one spotlight, one camera, and one claw. The body of the ROV is composed primarily of ¾" PVC pipe. The structure is a simple cube, approximately 18"x18"x18". The size of the ROV is decidedly small so that turning and maneuvering would be easy. Additionally, the ROV is weighted with 4-200-g weights and is ballasted with a small, donut-shaped inner tube. The ballast system allows the ROV to be approximately neutral-buoyant.

The propellers are large (approx. 4" dia.) and have the ability to move water effectively in both the forward and reverse directions. Two of the propellers are positioned on the vertical elements of the pipe structure. These propellers are responsible for forward/reverse motion. The forward/reverse props are diagonally across from each other, e.g. not adjacent. The team found that this orientation allowed for greater stability with respect to the vertical axis. Additionally, two propellers are placed on horizontal elements of the ROV. These props are responsible for assistance in up/down motion. While the ballast system is more effective for long-range vertical motion, the secondary up/down props are useful for minor corrections. For both the forward/reverse and up/down props, the pairs of propellers work in tandem for lateral motion and oppose each other for rotational motion.

The ROV is powered solely by a 12 V DC power source. A 30' long tether is connected to the power source. The tether has several table tennis balls attached to it. This allows the excess tether to float on the surface of the water, thus avoiding entanglement with the moving ROV.

In order to accomplish the Underwater Olympics tasks, a two-part claw was designed and built. The claw consists of two curved sheets of aluminum that are glued with 5-minute epoxy to metal rods (aluminum and brass). The rods are attached to small DC motors. The two halves of the claw are wired so that they spin in opposite directions. This allows the claw to grasp onto an object, such as a PVC pipe.

A single camera was also directly attached to the frame of the ROV. The camera is enclosed by a box of Lexan, which was formed with brass L-brackets and sealed with caulk. The camera is directed at the claw (forward direction).

Unique Challenge

The primary challenge for this team was to construct an ROV that was capable of ascending and descending. None of the primary team members had any experience with ROVs of any sort. None of the members had done any wiring or soldering. Additionally, the team's mentors were not experienced with the unique task of creating a marine ROV. Because of these shortcomings, the team set a modest goal of creating an ROV that could move in all directions with reasonable ease. The completion of the Underwater Olympic tasks was given a lower priority. Hopefully, future teams at Notre Dame Preparatory School will benefit from the current team's experiences.

Future Improvements

If there was more time to complete the project, several improvements would be possible. One useful improvement would be to water-proof the motors more carefully. In the current ROV, the motors were simply wrapped with electrical tape. This is not the most effective means of water-proofing a motor. A more robust design would be to enclose the motors in an oil-filled film canister with small openings for the shaft and wires.

Another improvement would be to add additional cameras and instrumentation to the ROV. The team members discovered that the two-motor claw was not very effective in accomplishing the tasks of the competition. However, there was insufficient time to correct this issue. One possible improvement to this challenge would be to use a professionally manufactured robot arm. Other ideas included a "hook" instead of a claw. A simple hook may have been able to accomplish Task #2 without the use of any motors.

Significant improvement to the ROV design may also be gained from using a more advanced controller. Notre Dame Prep also sponsors a team that competes in an autonomous robot competition. The use of a control board from such a competition would allow for a myriad of design opportunities. It may be advantageous to use servos for applications such as robotic arms, as opposed to motors.

Budget/Expense Sheet

School Name: Notre Dame Preparatory School
Instructor/Sponsor: Mrs. Barthel, Mr. Aronstam, Phoenix International

Date	Deposit/ Exchange	Description	Notes	Amount	Balance ($1,000)
1/27/05	(-)	Bought bulbs, cut wire, knife switch and lamp holder.	Equipment to begin the process of learning how to wire	$40.00	$960.00
2/16/05	(-)	Bought duct tape, roller box, 1X10 PVC, 60 QT, fitting and DRWR 17in.	Materials to being building our ROV.	$56.63	$903.37
3/16/05	(-)	Bought a clear can, PVC, spray paint, fitting and 2"INCSTW.	Materials used to build our ROV.	$50.31	$853.06
3/25/05	(-)	Bought 13 propellers, 13 motors and a speed control kit.	Equipment used to work our ROV.	$108.22	$744.84
5/04/04	(-)	Bought two toggle switches.	Equipment used to work the ROV.	$15.52	$729.32
5/15/05	(-)	Bought colored duct tape.	Materials used to build the ROV.	$16.76	$712.56
5/15/05	(-)	Bought fitting/	Used to help build the ROV.	$12.11	$700.45
5/21/05	(-)	Bought stepper motor, motor, computer solder, scotch tape and several rolls of colored duct tape.	Materials used to build the ROV.	$82.77	$617.68

Using ROVs to Explore and Understand our National Marine Sanctuaries

Many people do not understand the use of remotely operated vehicles, but in reality they are very useful in marine sanctuaries. ROVs are used to protect humans from dangerous situations, educate the public, and explore areas in the ocean that humans can not reach.

ROVs have been used in dangerous situations, for example, near hydrothermal vents. The Deep-Tow was an underwater instrument used on the Southtow expedition. It helped to find the hydrothermal vents along the Galapagos Rift. It was equipped with precision sonar, cameras, and geophysical sensors that transmitted data back to the ship through a cable (The Discovery of Hydrothermal Vents, NOAA). It was one of the first deep-submergence vehicles operated by civilian scientists. If the Deep-Tow had not been around for the scientists to use on the Southtow expedition, marine scientists would not have learned about hydrothermal vents because they are located too far beneath the surface of the ocean for humans to reach themselves.

Another example is the Monterey Bay National Marine Sanctuary. Scientists have been using ROVs to educate students across the country to help promote marine awareness. They have recently employed the LBV150, developed by SeaBotics, Inc., which is a small ROV that is used to transmit images and to allow people across the country to use it (SeaBotix.com). It has been designed to withstand prolonged saltwater exposure, which allows audiences from other aquariums and science centers across the nation more time to “drive” the vehicle and to see the beautiful images broadcasted to them. This ROV is connected to a suspended tether, which allows the audiences to guide it using the thrusters and cameras. These scientists hope to expand this program to other marine sanctuaries so the audiences will be able to compare the habitats and the wildlife that the ROV images provide.

In addition, ROVs are used to explore areas in the ocean that humans can not reach. For example, the discovery of the Titanic in 1985, would never of occurred without the help of Alvin and Jason Jr. Alvin is the first deep-sea submersible capable of carrying passengers, and it can dive to depths up to 14,764 feet deep (NOAA Ocean Explorer: Alvin). Alvin carried Dr. Ballard and other scientists down to the wreckage of the RMS Titanic in the 1980's for the exploration of the sunken ship. Along with the use of Alvin, Dr. Ballard used Jason Jr. Jason Jr. is a smaller prototype of Jason that was able to get into small areas that Alvin could not reach. Without the help of Alvin and Jason Jr., scientists would not have been able to explore the ship, find out how it sunk, or study the development of rusticles that grow on the ship.

Skills Gained

The team was able to gain skills such as patience and cooperation. At the beginning, our team didn't have the capability to work together to form different ideas and designs. Gradually, we learned we had to work together and listen to each other to get the ROV finished.

Our team had no experience in building robots, but we had the patience to learn. The team researched online about making robots and learned from our instructor Mr. Aronstam. He taught us many skills, including how to sodder and how to wire our electrical systems. At first, no one even understood how to wire. The first weeks we learned all about simple circuits. We began very small with just a battery and light bulb then gradually added more, such as a switch to turn the bulb on and off. Eventually, our team learned how simple circuits worked, allowing us to build the ROV.

Our One Challenge

One challenge that our team faced was with the designing and constructing of the arm. Our team went through various designs, when we settled on a two-jointed mechanical arm that rotates at the wrist. Though we had the design, we had no idea how to construct the arm. We thought about using different objects such as claw. And we even looked for pre-built mechanical arms online. Though we found some, they all were either too expensive or not waterproof. We decided upon making our own arm, with two sheets of metal.