Technical Report

Submitted June 2, 2006

Science Club: ROV Group

Project: Pacific Sea Bugs

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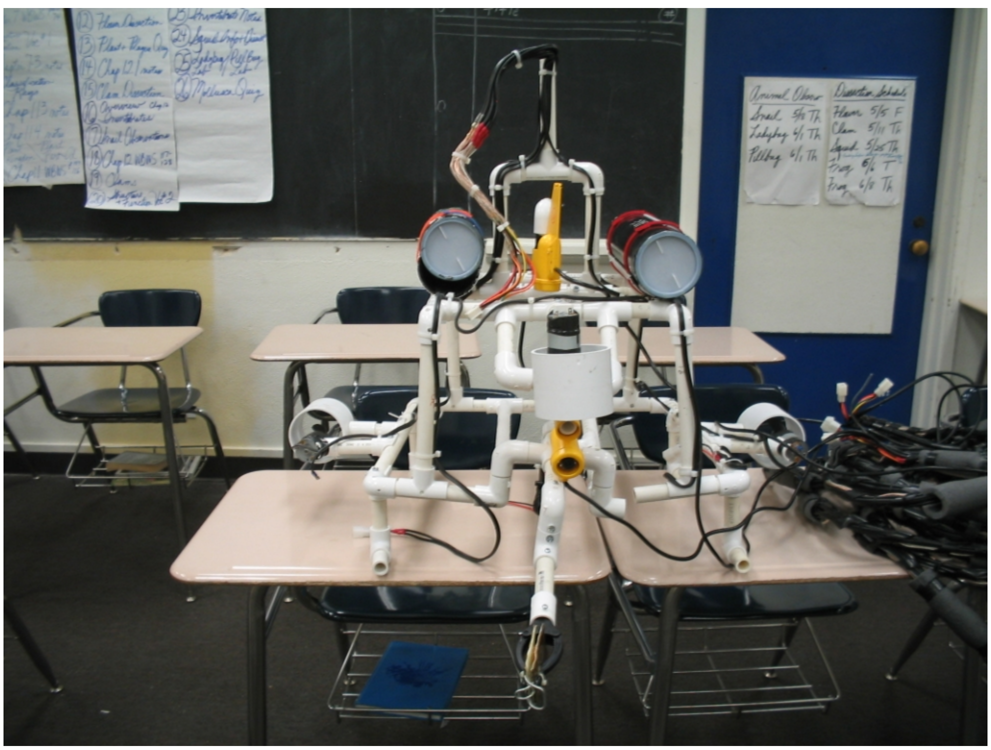
2006 MATE Center/ MTS
ROV Competition
June 23-25, 2006



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Abstract

A remote operated vehicle (ROV) is a mechanical device that is operated by an outside source and is used to venture in dangerous environments. The Dana School ROV Team from Hawthorne California has constructed a vehicle to compete in the MATE (Marine Advanced Technology Education) International Competition in Houston Texas on June 23-26, 2006. The vehicle is constructed from PVC pipe, four 12V DC motors, a 1.8 Kg lead ballast, and two ABS sealed floats. The tether uses 23 conductors to transfer power and information. Both the vehicle and the tether are neutrally buoyant. The control box (interface) is made from a steel chassis, a PVC joystick, and five DPDT center position off switches. Two night vision cameras that operate in zero LUX, each with eight infrared LED's are mounted to the ROV. The competition will simulate maintenance on Marine observation platforms. Our ROV uses a solenoid to secure an instrument package to the ROV and an arm using a car door lock actuator to open and close a claw for grasping. The total cost of our ROV was approximately $600.

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Introduction

A Remote Operated Vehicle (ROV) is an underwater device that is controlled by an operator away from the actual vehicle. This allows the driver to operate in a safe environment. ROVs can be sent into areas where it is dangerous for humans to venture, like the depths of the ocean or far out into space. There is nothing more practical, safe or cost efficient than using an ROV to explore the deep sea.

Dimitri Rebikoff, a French underwater photographer, developed the first tethered ROV, named POODLE, in 1953. The military used ROVs in the 1960's to search for lost ordinance underwater. In the 1970's, commercial firms saw the future of ROVs, advancing the technology to support offshore oil operations. The police have been using them to detect and disarm bombs, and search houses and premises when there are signs of danger. One of the more famous ROVs is Jason Jr., the ROV that explored the Titanic in 1986. Today, you commonly hear about ROVs in the news, with the recent Mars Rover expeditions and the Unmanned Aerial Vehicles (UAV) the military uses in the war on terrorism. Marine ROVs are used for many purposes, such as repairing communication links, collecting and recovering samples, and hunting for sunken treasure.

The Dana ROV team started out in the electronics division of the Science Club in the spring of 2004. The original Dana group built a small ROV and tried it off the coast of Marina Del Rey, CA but it was not very stable and it didn't move very well. A team was formed in the fall of 2004 to compete in the 2005 Regional Southern California Flyoff. The team earned 2nd place at the regional, and then 5th place in the Ranger Class at the National MATE competition in Houston Texas. In the 2005-2006 school year, Dana School offered an electronics elective class. Eight students that class formed the 2006 Dana ROV team.

Our first objective is to win at the 2006 MATE Center International Competition in Houston Texas. We placed 1st at the 2006 regional competition in San Diego. The tasks to complete in Houston are based on ocean observing. We will simulate restoring power to a network of observation devices in task 1 and releasing a damaged acoustic instrument package in task 2. We hope that this experience takes us farther in our future. Even though each team member's future paths will go different ways, we hope that each on of us becomes proficient and masterful. We are proud to be competing in the 2006 MATE Center International Competition and to take part in this amazing opportunity.

Figure 1. Electronics module inside trawl resistant frame.

Task 1

The first task simulates lowering and installing an electronics central module into a trawl resistant frame on the ocean floor using our ROV. Power is then connected to the module by inserting a rod-like probe into the module. The central module's purpose is to transfer power from the shore and receive data from other underwater electronic sensor devices. Power is supplied directly from the shore by cable. Cables branch off the central module and connect to the other electronic devices or collecting instruments. Ocean floor data (e.g. temperature, water movement, pH, salinity, and pressure) is collected and is transmitted back to shore by cable. We realize task 1 is a simulation, but if we were to actually do this, our ROV would have to be much larger and more powerful to carry a much heavier electronics module down to the bigger trawl resistant frame.

Task 2

This task simulates the manual release of an instrument package from a malfunctioned acoustic release transponder near the central node from the ocean floor. The instrument package contains a number of instruments to analyze underwater conditions including conductivity, temperature, and pH. An acoustic release transponder should release an object after it receives a sound signal. Task 2 is completed once the instrument package is released. We must do this manually by pulling a pin with our ROV releasing the positively buoyant instrument package.

Electrical Schematic

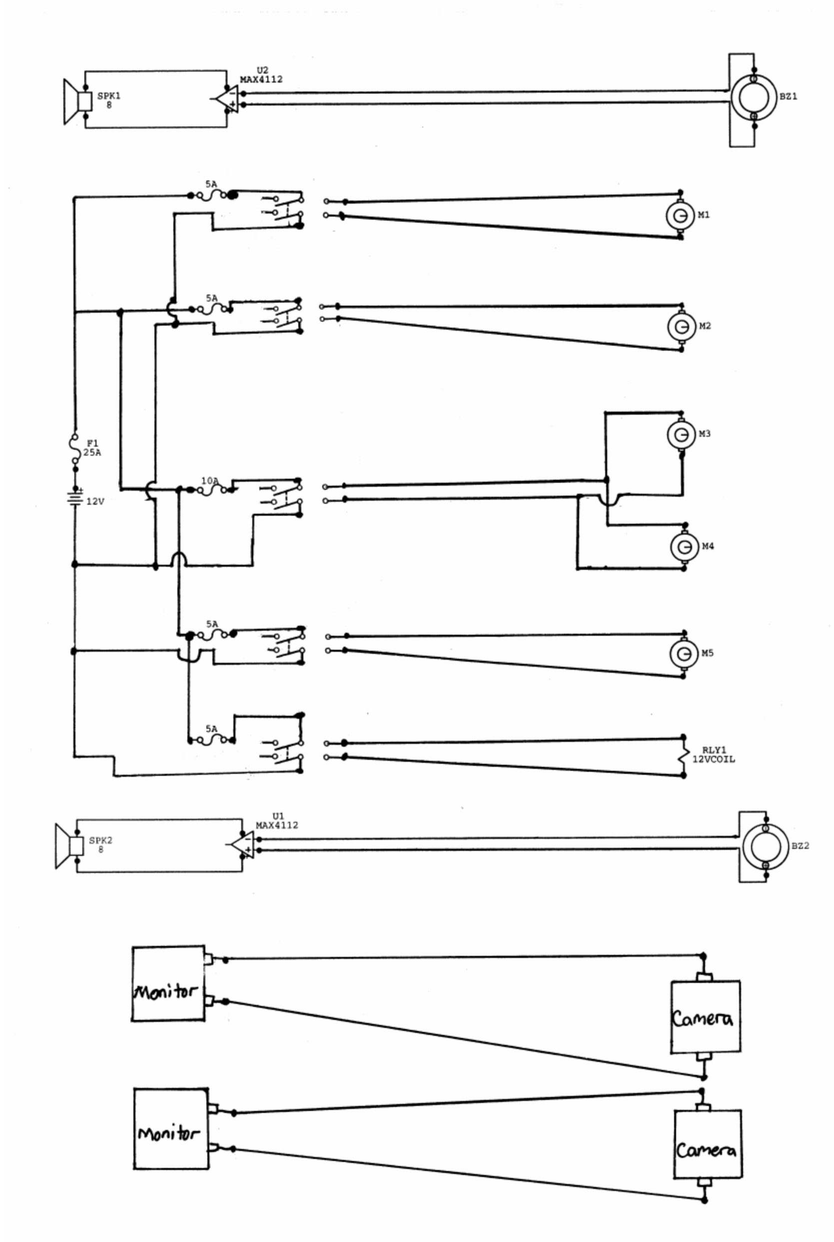


Figure 2. Schematic of 2006 Dana ROV Electrical System

Design Rationale
Vehicle

Figure 3. Photo of ABS float.

Our design objectives for our ROV were to maximize stability, be neutrally buoyant, and complete the mission tasks in the shortest amount of time. To prevent things from going wrong, we applied the K.I.S.S. (Keep it simple stupid) principle and kept our design simple. Control of the ROV is left to the driver. No software is used. Our ROV has constant neutral buoyancy. Elevation in the water is controlled by the up and down motors. We based the initial dimensions of our ROV on the electronic module of task one.

The ROV's box frame (dimensions 49cm x 72cm x 47 cm) is constructed from 12.7 mm inner diameter PVC (Polyvinyl Chloride) pipe and connectors. We achieved maximum stability by having a low center of gravity and a high center of buoyancy. PVC has a specific gravity of 1.42. PVC is easy to work with, inexpensive, durable, and can be found at most hardware stores. All the angled connectors are 90 degree angles. All the PVC T's on our ROV are clamped on allowing the ROV to have 10 firm lengths of PVC. Most of the PVC connectors were secured with screws and instead of glue. Many 5mm holes were drilled into PVC to allow water to quickly fill the hollow tubing and eliminate air pockets, which would affect our buoyancy. The depth rating of our ROV is at least 3.7 m.

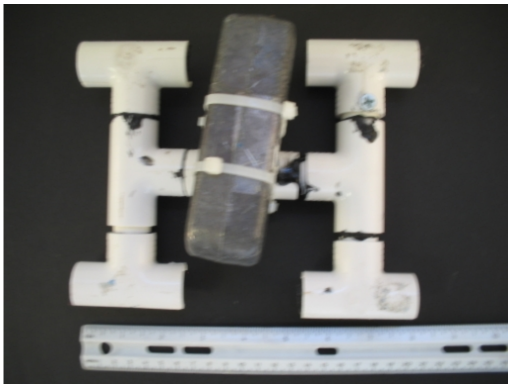


Figure 4. Photo of the lead ballast we used on our ROV.

To achieve maximum stability, we have a 1.81 kg lead (specific gravity 1.42) diving weight (Figure 3) attached to the bottom and two floats made from 7.62 cm diameter ABS (Acrylonitrile-Butadiene-Styrene, specific gravity 1.02-1.17) sealed hollow tubes on the top of the ROV (Figure 3). The ABS tubes are sealed with plug on ABS caps using plenty of epoxy. Several ABS tubes were cut to different lengths to adjust the volume of the floats. The lead weights are mounted on a PVC frame (Figure 4) and are attached to the ROV using Velcro strips. Using Velcro allows us to adjust the position of the lead weight and change the center of gravity of the ROV. The acrylic floats are held in place on styrene half pipes using Velcro strips. Again, the Velcro allows us to adjust the position of the floats to change the center of gravity. The floats are the only sealed containers on the ROV.

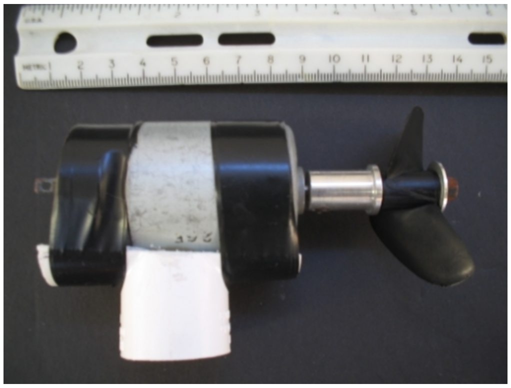


Figure 5. 12 V D.C. Brush Motor.

Motors

We have one 12 volt D.C. (Direct Current) motor on each side of our ROV (front, back, left, and right – total of 4). The front and back motors control elevation and the right and left motors are used to turn and move the ROV forwards and backwards. Attached to each motor shaft is a two bladed 56 mm diameter propeller (See Figure 5). PVC mounts are used to attach the motors to the ROV frames and the motors can be easily replaced or adjusted to different positions or angles. PVC covers are used to protect the propellers, direct the motor thrust, and prevent anyone from touching the blades.

We determined our motor's performance by measuring the thrust at voltages. We used spring scales to measure the amount of thrust that the motor pulls in water. The measurements were done in a 37.85 liter aquarium. The results (see Table 1) and test setup (see Figure 6) are shown below.

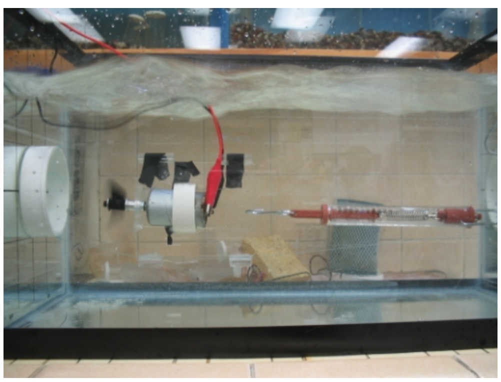


Figure 6. 38.785 liter test tank with motor.

Table 1. Voltage vs. Force

Voltage (Applied to the motor)	Amps	Force	Power (Electrical Power)	Scale (Range of Spring Scale)
2.02V	**.30A**	**.0N**	**.6W**	**0-2.5N**
2.7V	**.42A**	**.0N**	**1.13W**	**0-2.5N**
5.54V	**1.11A**	**.49N**	**6.15W**	**0-2.5N**
5.6V	**1.14A**	**.78N**	**6.38W**	**0-2.5N**
6.05V	**.95A**	**.44N**	**5.7W**	**0-2.5N**
8.9V	**1.88A**	**1.61N**	**16.73W**	**0-2.5N**
11.3V	**2.56A**	**3.53N**	**29.00W**	**0-20N**
12.6V	**3.06A**	**4.11N**	**38.00W**	**0-20N**

Payload Tools


Figure 7.Robotic Claw

Our ROV uses two mechanical payload tools: a home made robotic arm and a small solenoid. The robotic arm consists of an actuator that can open and close a modified claw that includes two pieces of plexiglass. A cone shaped device is attached to the claw to hold the power cable probe in Task 1. The actuator is connected to a long pin that is threaded through a 13.97 cm length of PVC and pulls on two small plastic pieces that open and close (See Figure 7). We use our robotic arm to open the door, pick up the power cable probe, and insert the probe for Task 1. It is also used to pull the pin in Task 2. We use a solenoid (See Figure 8) to secure the electronics module to the ROV and release it in the trawl resistant frame of Task 1 (See Figure 1). The throw of the solenoid is 2.0 cm. Four L shaped arms underneath the ROV keep the electronic module from swaying.


Figure 8. Solenoid

Sensors

Two waterproof video cameras (See Figure 9) (Chicago Electric, 12 volt DC, 2 watt, 270,000 pixel) are mounted to the ROV. The cameras are capable of night vision and work in 0 LUX illumination. There are eight infrared LEDs on each camera. Camera 1 is pointed forward and is used to view the robotic arm and where the ROV is going. Camera 2 is pointed downward and is used to view the position of the trawl resistant frame and the solenoid to release the electronics module.

A right and left piezo crystal microphone is mounted on each side of the ROV and allows the driver to hear the motors underwater. The driver is capable of distinguishing whether a motor is moving or not. The microphones can also be used for listening to other sounds underwater such as whale noises. The piezo crystals convert sound energy to electrical energy and passes the electrical signal to the headphones.

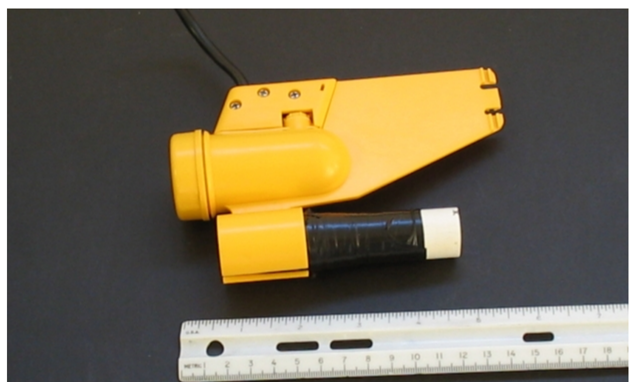


Figure 9. Video Camera

Tether

The tether for the ROV is used to transfer power to the ROV and audio and video information back to the driver. Our tether is 16.764m long. There are three wire connectors that attach the tether to the ROV. This allows the ROV to be quickly attached or released from the tether (See Figure 11) are three connectors that attach to the control box and one connector for each camera. The tether has 23 conductors to supply power to the ROV, open and close the robotic arm, open the solenoid to release the electronics module, and transmit the video and audio signal to the surface.

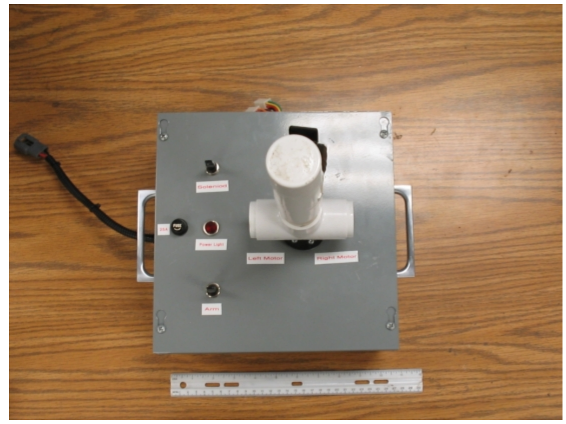
Conductor	Function
1	Positive conductor to right motor
2	Negative conductor to right motor
3	Positive conductor to left motor
4	Negative conductor to left motor
5	Positive conductors to up and down motor
6	Negative conductors to up and down motor
7	Positive conductor to actuator motor on robotic arm
8	Negative conductor to actuator motor on robotic arm
9	Positive conductor to solenoid
10	Negative conductor to solenoid
11	Positive conductor to monitor camera 1
12	Negative conductor to monitor camera 1
13	Positive conductor to camera 1
14	Negative conductor to camera 1
15	Conductor for video feed for camera 1
16	Positive conductor to monitor camera 2
17	Negative conductor to monitor camera 2
18	Positive conductor to camera 2
19	Negative conductor to camera 2
20	Conductor for video feed for camera 2
21	Conductor to left piezo crystal
22	Conductor to right piezo crystal
23	Ground wire for left and right piezo crystals

Figure 10. Illustration of Tether

The conductors are sealed in plastic spiral wrap for protection and spot ties are used at 15.24 cm intervals to hold the wires together. Foam pipe insulator is added at regular length intervals to shape the tether underwater and give the tether neutral buoyancy.

Figure 11. Coiled Tether with cameras attached

Control System



Our control box acts as an interface. An interface is a device that links the driver of the ROV to the ROV's movements. Our present control box evolved from 2 previous versions. The first control box the team designed was hard to control because of the switch placement and didn't have enough switches.

Our second control box was much better because it allowed the operator to control the right, left, up and down motors with one hand by adding a joystick that we made out of PVC. We also added a speed control circuit to vary the speed of the motors and a small fan to keep it cool. After testing, we found that the speed control wasn't giving us a big enough range of speed so we took it out of the box. The second box was made out of a Plexiglass to make it easier to see if we blew a fuse.

Now our third control box (See Figure 12) is basically the same as the second control box but with a few added features. The new box has a power indicator light that tells the operator if there is power to the box. Another feature is a chassis mount fuse holder that is located on top of the box which makes it easier to change the main fuse if it ever opens. Although the Plexiglass chassis of the second box allowed us to see if a fuse had blown, but the third control box we used a steel junction box that would go in a house. It is a little heavy but it has rubber feet on the bottom so it doesn't slide around.

Overall, our first two control boxes were building blocks for the third box, we are still using the first two control boxes as backups. Although the first box was hard to operate, it is still an interface as are the second and third control boxes.

Safety

Our ROV is made of mostly environmentally safe materials. There is no battery on board, so there is no chance of a battery acid leak. The PVC frame and ABS float tanks of our ROVs are insoluble in water and harmless to creatures of the sea. However, our ballast and solder is made of lead, which is poisonous. The solvent that holds our floatation caps to the floats is probably toxic and parts inside the motors may be potentially harmful to sea life.

Budget

2006 MATE/ MTS ROV Committee Student Competition							
	Item	Description	Source	Part Number	Price/unit	Qty	Ttl Price
Structure							
	PVC three way connectors	PVC tri corners	Home Depot		$3.40	2	$6.40
	PVC four way connectors	PVC cross connector	Home Depot		$ 0.58	4	$ 4.58
	PVC elbow	PVC right angle connector	Home Depot		$ 0.14	30	$ 4.20
	Tri corners	1/2 in tricorners	Home Depot		$0.18	4	$ 7.20
	Polystyrene rain gutter tubes	27 1/2 cmx 9cm polystyrene	Home Depot		$ 3.12	2	$ 3.12
	PVC pipe	29 1/2 cmx 8 1/2 cm PVC	Home Depot		1.19/10	10	1.19
ropulsion							
	DC motors	DC motors	arash:Motors LTD	36-41113	st:$3.00	4	donated
	Propellers	Propellers	Precision Engr.		2.75	3	8.25
	Propeller coupler	Propeller Coupler	Hobby People		8.00	4	32.00
Floats	Float tube	75mm Float tube	Home Depot		1.13	2	2.26
	Float caps	ABS plug test caps	Home Depot		0.65	4	2.60
	Acrylic Pipe	Clear plexiglass pipe	Plastic Depot		10.50	2	21.00
Ballast	Ballast/ Diving Weight	1.35kg lead diving weight	Dive and Surf		3.00	1	3.00
	PVC four way connectors	PVC cross connector	Home Depot		0.58	4	4.58
Tether	16 gage speaker wire	Copper speaker wire	Home Depot		5.39	5.8m	5.39
	24 gage audio cable	Audio Cable	Radio Shack	278-513	8.79	5.8m	8.79
	Spot Tie	Holds tether twists in place	Mr.Sheneman		5.00	.0m	donation
	Spiral wrap	Holds tether wires in place	ignal Electronics		13.18	5.8m	13.18
	Zip Cord	Zip Cord	Home Depot		64.00	5.8m	64.00
udio/ Video	Phone Jack	older- Type Stereo In line Jack	Radio Shack	274-274	2.00	2	4.00
	Video Camera	Video camera system	Harbor Freight		108.00	2	216.00
	Microphones	Piezo crystal microphone	NG Swap Meet		0.75	2	1.50
rm/Solenoid	Solenoid	olenoid to attach ROV to box	All Electronics	T#SOL-58	1.50	1	1.50
	Arm	Arm to grab probe/door	99 cents store		0.99	1	0.99
	Plexiglass	Used on arm	Mr.Foster		crap:$1	cm2	donation
	Wire	Used in arm	Mr.Foster		st.$ 0.50	2cm	donation
	Egg	Used as part of claw	Michael's		0.99	1	0.99
ontrol Box	Box	Box 10x10 by 4 junction box	awthorne Elec. Su.		12.50	1	12.50
	Toggle switches	DPDT momentary, ctr switch	Radio Shack	275-709	4.49	3	13.47
	Rocker switch	Rocker switch	ignal Electronics	35- 3525	10.00	1	10.00
	Red Panel Light	Red Panel power light	ignal Electronics		2.37	1	2.37
	Four position fuse block	Fuse holder	Radio Shack	270-742	2.29	1	2.29
	Handle	Box handle	ignal Electronics		$1.69/2	1	$1.69
	10 pole barrier strip	10 pole barrier strip	ignal Electronics		4.50	1	4.50
	5 pole barrier strip	5 pole barrier strip	ignal Electronics		2.51	1	2.51
	Rubber feet	Rubber box feet	All Electronics		0.45	4	1.80
	Bearing	Bearing	Earl's Liquidation		1.00	1	1.00
	Fuse block	Fuse block	Radio Shack	27-742	2.29	2	4.28

	·emale spade connectors	Electrical connectors	Home Depot	st:$0.99	30	donated
	Ring terminals	Ring terminals	;ignal Electronics	st:$0.99	27	donated
	Barrier strip jumpers	Barrier strip jumpers	;ignal Electronics	25/8.00	4	1.28
	Screws 10- 24	10- 24 Machine screws	Home Depot	st:$0.99	4	donated
	Washers	#10 washers	Home Depot	st:$0.99	4	donated
	Nuts	10-24 nuts	Home Depot	st:$0.99	4	donated
	Screws 6-32	6-32 Machine screws	Home Depot	st:$0.99	7	donated
	Washers	#6 washers	Home Depot	st:$0.99	7	donated
	Screws 8-32	8-32 Machine screws	Home Depot	st:$0.99	8	donated
	Washers	#8 washers	Home Depot	st:$0.99	6	donated
	Nuts	8-32 Nuts	Home Depot	st:$0.99	6	donated
	Nuts	6-32 Nuts	Home Depot	st:$0.99	7	donated
	Rubber Grommets	9-16th rubber grommets	Home Depot	0.69	1	0.69
	Spacers	6-32 spacers	All Electronics	st:$0.99	4	donated
	Fuses	Glass 10 Amp fuses	;ignal Electronics	0.47	1	0.47
	Fuses	Glass 5 Amp fuses	;ignal Electronics	0.47	5	$2.35
	Fuses	Glass 25 Amp fuses	;ignal Electronics	0.47	1	donated
	Tees	Tees 1cmx1inx1in	Home Depot	0.49	2	$0.98
	Cap	1 in cap	Home Depot	0.42	1	0.42
	Plugs	1 in plugs	Home Depot	0.42	2	0.84
Misc.	Velcro Straps	Holds floats to ROV	Home Depot	0.60	8	4.80
	Velcro Tape	Roll of velcro tape	Home Depot	6.69	1	6.69
	Wire Tie	100 pack 10.16 cm	IGST Swap meet	1.25	1	1.25
	Wire Tie	100 pack, 330.48 cm	IGST Swap meet	2.50	1	2.50
	Wire Tie	100 pack 20.32cm	IGST Swap meet	1.67	1	1.67
	Electrical Tape	Electrical tape	Home Depot	0.59	1	0.59
	Solder	Solder	Home Depot	8.76	1	8.76
	Hot Glue	Hot glue	Home Depot	0.99	1	0.99
	Silicone Cement	Silicone cement	Home Depot	6.99	1	6.99
	Shrink Tubing	Covers exposed wires	IGST Swap meet	1.00	1	1.00
	ABS Glue	ıdhesive for float caps to tube	Home Depot	7.87	1	7.87

ROV cost:$69.80
sensor cost:$221.50
ol box: $63.44
ılsion: $40.25
r:$91.36
Cost:$519.94

Challenges

While building our ROV for this year's competition we faced several different challenges. Our first ROV was too small and could not perform Task 1. The up and down motors were positioned over the electronic module so the water propelled hit the electronic module so we were not able to move up. To overcome this, we designed a larger ROV that moved the motors away from the electronic module. We built our new ROV around stability and neutral buoyancy. We ensured the ROV would be stable with the electronics module by increasing the weight and the size of the two large floats. The definition of stability is the ability of an object to resist change and/or revert to a normal state after being disturbed. We had to make the weight relatively large because of the large size of our ROV. We also had to achieve neutral buoyancy, which is when the buoyant force of an object is equal to the weight of the fluid displaced by that object.

We also had some major issues on what materials to use for our floats. We had originally made them out of ABS pipe, but we could not easily tell if they were leaking and we had difficulty sealing them. We have now moved on to acrylic pipe, which is clear, allowing us to see if there is any water inside. It is still difficult to seal them, but it is much easier to inspect for leaks compared to the ABS.

We had difficulty securing the electronics module in Task 1 to the ROV. We were using five L shaped PVC arms to attach the module to the ROV. Because of the size, mass and buoyancy of the module, the module kept falling off the ROV in the water. Releasing the module was also a challenge to be considered. We were able to solve both problems by adding a solenoid (electromagnet) to the center arm. The solenoid in the closed position would secure the electronics module and when open, the driver could maneuver the ROV and release the module.

Figure 12. Robotic Arm (version1)

Figure 13. Robotic Arm (current)

This year at the competition in San Diego, our robotic arm could not properly hold the probe in Task 1. The arm was able to open the door in task 1 and pull the pin in task 2 but the power cable probe kept swaying from side to side and we could not make the connection. Now we have a small egg-shaped piece of wood that holds the probe still (See Figure 13)

Our motors have always been a challenge. Because we are using inexpensive motors, the motor power terminals easily rust and often break off (See Figure 14). Fortunately, they are easily replaced. The propellers had to be attached using special prop connectors. Possibly our greatest challenge this year was finding suitable motors. Last year we were able to compete with motors that drew 6 amps of current. This year however, we could not find those same 6 amp motors. We discovered that the ones we had been using were not being sold anymore. The only available motors we could find drew more than 10 amps. As our design required 4 motors, this was unacceptable according to the 25 amp maximum rule of the competition. In San Diego, we were fortunate to compete with four old but still functioning motors from last year. These same motors,

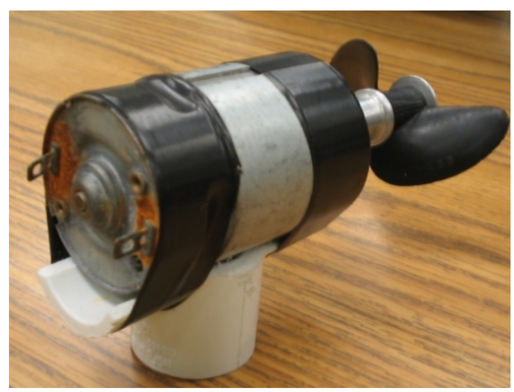
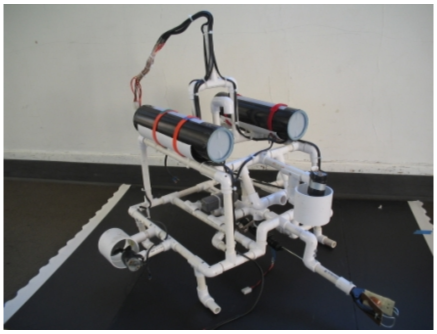


Figure 14. Rusty terminals on old motor

however, would not last until our competition in Texas. For the International competition, we had to find a motor that drew a limited amount of current underwater. Luckily we were able to track down the manufacturer (Igarash: Motors LTD) from last year's motors and contact them. When told of our problem, they were nice enough to donate several motors for our project. These new motors draw 3 amps of current underwater.

The ROV we used in the 2006 regional competition had some design problems. The position of the front up and down motor forced the arm to extend way out in front of the ROV Any minor side-to-side movement of the ROV caused the arm to move out of position. This made positioning the arm very



difficult. By repositioning the front motor over the arm, our current ROV uses a much shorter arm (See Figure 15). thus making our ROV easier to control.

We also found that the frame was much weaker because all the short lengths of PVC, four-way, and T connectors were starting to come apart and bend. To strengthen the ROV frame, we rebuilt our ROV using longer lengths of PVC and attached the motors, motor covers, and cameras with cut PVC T connectors.

Overall, we have accomplished a lot working together and learned something new from each and every challenge. Fixing the problems has been an exciting and rewarding experience for all of us.

Troubleshooting

While at the International competition we hope the K.I.S.S. principle will eliminate or reduce any problems. However, we are prepared to overcome many unexpected difficulties. For example:

If the propellers do not turn:
1. Check physical connections between battery, control box, tether, and ROV.
2. Check fuses.
3. Check connections with voltmeter.
4. Check battery with voltmeter under load.

If the robotic arm does not open:
1. Check physical connectors.
2. Check fuse.
3. Check actuator.

If the ROV moves slowly:
1. Check the battery with a voltmeter under load.
2. Check electrical points for voltage drop with voltmeter.
3. Check connectors for good electrical contact.
4. Replace motors.

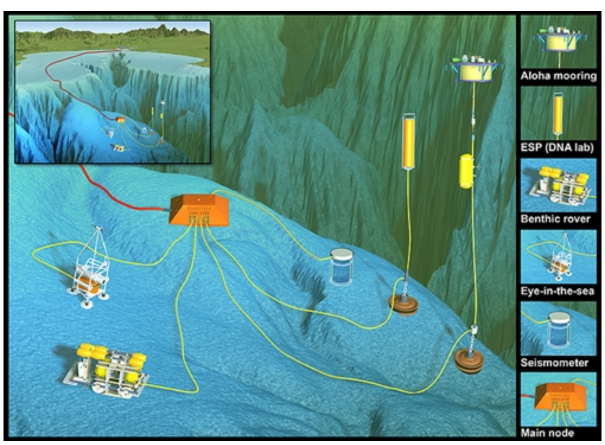
If the fuses keep burning out:
1. Check the motors, arm, and solenoid.
2. Check fuses we’re putting in.
3. Replace motors, solenoid, or actuator.

Lessons Learned

As we worked on our ROV, check off sheets became crucially important in many ways. We made check off sheets for purchasing items, deciding what to bring, and improvements that needed to be finished. This way we could easily check off the things we had already accomplished and focus on what needed to be done. Another valuable lesson that we learned was accepting responsibility when others could not come through, and how to vote when we came to a disagreement. We learned basic principles such as buoyancy, Archimedes's principle, and stability. Pool time was crucial because we needed to test our ROV and try out the tasks. Teamwork made it possible for all of this, including building our ROV and designing our poster board. During this competition we had some luck, especially in the Southern California Fly – Off when our ROV was alternately positively and negatively buoyant just before the competition.

Future Improvements

In the future, the Dana ROV Team hopes to make several improvements to enhance the speed and agility of the ROV and make maintenance less of a problem. Some of these improvements include looking for switches that have metal bases because the plastic threads get stripped. We would also like to add a strafing motor to improve the maneuverability of the ROV. We would like to control buoyancy with hydraulics and eliminate the up and down motors. We would like to reduce the number of conductors in our tether by using fiber optics, radio waves, or on-board batteries.



Career Opportunity

The first task in the MATE ROV competition is to deliver an electronic module down to a trawl resistant frame and supply power to the module. This task simulates the building of a central node on the ocean floor. The Monterey Accelerated Research System (MARS) is a project run by a group of ocean exploring corporations installing a network of seafloor observatories in the Monterey Bay. These seafloor observatories will need to be built and maintained by ROVs. Some organizations participating in this project are the National Science Foundation (NSF), Monterey Bay Aquarium Research Institute (MBARI), University of Washington, Jet Propulsion Laboratory (JPL), and the Woods Hole Oceanographic Institution. MARS is placing and powering instruments in various undersea sites to study ocean geography. They are going to install a science node on 51km of submarine cable with the ability to link more nodes. It will deliver 10 kW of power to 8 different ports. The MARS program will use ROVS and support ocean observation for years to come.

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MATE (Marine Advanced Technology Education) Center

MTS (Marine Technology Society)

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