

ROV *Rumble Bee*
MPC ROV Club



Members:

Khrysta Moe, Bernard Roth, Alfredo Ortegalius,
Joe Rodriguez, Tylar Murphy, Josh Sampey

Instructor:

Tad Masek

Abstract:

Rumble Bee was designed to withstand freezing temperatures and moderate currents. Her dense, lightweight frame allows for minimal resistance in current, while the materials that were used are rated for temperatures below freezing. Two of the three color cameras have wide-angle lenses to better see the ice sheet above the ROV and the designated zones below the ROV. The controls are comprised of two analog sticks that send data down the tether to direct the motors in which direction to go. Four motors allow the ROV to move in multiple directions which include; up and down, forward and backward, crabbing left and right, as well as rotation. There are also several different tools that can be attached to the ROV that are used for completing the required tasks. These tools include an algae scraper, hooks, and a manipulator.

This paper will discuss in length the different components of the ROV, its electrical design, and a flow diagram for the software. Also included will be a list of our expenses, different challenges we faced and had to overcome as well as improvements we would like to do for next year.

Cultural History:

In very cold climates, there is a constant danger of developing hypothermia. Hypothermia begins to occur when the core body temperature drops to 94° F. (34.4° C.). Below 85° F. (29.4°C.), the body cools more rapidly because its natural temperature regulating system usually fails. The now rapid decline in core body temperature is likely to result in death. Humans and many other mammals have unusually efficient internal temperature regulating systems that automatically maintain stable core body temperatures in cold winters and warm summers. In addition, people have developed cultural patterns and technologies that help them adjust to extremes of temperature and humidity.



A much more effective cultural response to extremely cold temperatures is the use of insulating clothing, houses, and fires. People all over the world also adapt by limiting outdoor activities to warmer times of the day. In some societies, sleeping in family groups with bodies pushed up against each other is also done in order to minimize heat loss during the cold months of the year.

When the environment is very cold, life can depend on the ability of our bodies to reduce heat loss and to increase internal heat production. As Bergmann and Allen observed, the human physiological response to cold commonly includes the evolution of more massive, compact bodies with relatively less surface area. Shivering can also cause a short-term warming effect. The increased muscle activity in shivering results in some heat production. There are

three additional important types of biological responses to cold conditions found among humans around the world.

Different populations usually develop at least one of three different types of biological responses to cold climates. People living in harsh sub arctic regions, such as the Inuit of the far northern regions of the Western



Hemisphere and the Indians of Tierra del Fuego at the southern end, traditionally consumed large quantities of high calorie fatty foods. This significantly increases the basal metabolic rate, which, in turn, results in the production of extra body heat. These peoples also wore heavy clothing, often slept in a huddle with their bodies next to each other, and remained active when outdoors.

Design Rationale:

The *Rumble Bee* exterior was designed to be small and compact (55cm x 40cm x 61 cm). This was to minimize the drag from swell and current. Its square plastic frame withstood a stress and temperature test that attempted to reproduce a cold, harsh environment. To do this we placed a 30cm x 60cm piece in a freezer for about 30 minutes. After removing the frozen piece, it was secured with table clamps and then struck with a hammer. This test was done multiple times and struck in various places to insure its durability.

The vertical motors are placed to the side because the solid structure would not allow good propulsion for a centralized motor. These two motors are also bent at an angle of about 35 degrees. Having them at this angle provides the ROV with the ability to crab left or right. The horizontal motors are also on the side just below the vertical motors. Again this placement was based on the solid frame. They are angled to roughly 45 degrees. This provides us with great forward and backward motion and places the center of torque as close to the center of rotation of the ROV as possible. There are three cameras used to navigate through the water. The main forward camera is a 12:1 zoom color camera that allows us to see as much of our surroundings as possible. One of the two smaller color cameras is placed in an upward position so as to be able to view the algae under the ice sheet as well as the entry hole so we don't get lost. The other faces downward so as to easily spot the designated area for the PAS and to locate jellies. The tether was one used last year that was donated by Video Ray. Its neutral buoyancy and small size was a bonus limited the total drag of the system.

The control systems include two PIC microcontrollers. The topside microcontroller was placed in a redesigned Playstation controller. The Playstation had two analog joysticks. The right joystick controlled forward/reverse and crab left/right, while the left joystick controls up/down and spin left/right. The topside microcontroller takes in the analog inputs and turns them into digital signals that are sent down the tether by standard serial protocol. The second microcontroller

was housed in an Pelican case in the ROV and is referred to as the bottomside controller. The bottomside microcontroller takes the digital signals, process them to control the speed and direction of the four motors. We decided on PIC chips for their great flexibility with attachments as well as cost. The PIC is more cost effective than the microcontrollers used in last year's ROV. Another reason used the PIC was to learn technology that is common in the industry.

One Challenge:

There were several challenges we faced, but the biggest would have to be the lack of resources. There was only one place that we could meet to work on the ROV and it was the only place that had all the tools we needed. However this was the autoshop in campus and the time slots available to the team were limited. When the team did meet we would occasionally have to give up the tools we were using to the students who were taking classes at those times. Compounding this problem was the conflicting work schedules of team members. Regrettably, there were weeks when we could only concentrate on the ROV for about two hours per week.

Troubleshooting:

One of our greatest issues was getting the firmware to work with the motors. The main tool we used for troubleshooting was an oscilloscope. By attaching the leads to our data lines we were able to tell if the two PIC chips were communicating and if any commands were being sent down the tether. The methodical and consistent tests we ran each time we had issues would reveal to us that we had accidentally crossed data lines, had a short in the bottomside controls, or that the PIC just wasn't sending data.

Another tool used that helped tremendously was a multi-meter. With these little gadgets we could determine if the system was getting enough power or too much. In one of the cases where it seemed that nothing was working, we were able to determine that the voltage regulator in the bottomside electronics was not powerful enough to handle both the electronics and the PIC programmer. We noticed when we tried to program the voltage would sharply drop. We put in a regulator with a higher current limit and everything work during programming.

One more important issue we ran across were power surges when the motors were running. The power spikes coming from the batteries caused the bottomside PIC to reset itself. After diagnosing this with a power LED and the multi-meter, we fixed the problem with the addition of a capacitor to filter the power spikes.

Lessons Learned:

Every person on the team was able to walk away with something gained from this experience. Half of the team members were completely new to building

ROVs and they learned about all that goes into designing a ROV. For example the principles of center of gravity and center of buoyancy and how the viscosity of water causes a larger current draws on the motors than that of air. Those that had participated in these competitions before admitted to learning more about electronics and the use of firmware. All in all, everyone was pleased with what they were able to take away from their time spent with *Rumble Bee*.

Future Improvements:

There is always room for improvements, but only a couple will be outlined here. The one that everyone can agree on is to build and test things early and before we put them on the ROV. There were a couple of ideas and designs that should have been discarded long before we attempted to attach them to the ROV. Other ideas included adding sensors to the ROV that could make it useful outside of the competition. Such sensors would include a battery sensor to read the voltage of the battery, a compass for direction when visibility is poor, outside temperature, and pressure.

Expenses:

<u>Parts</u>	<u>Cost</u>	<u>Purpose</u>
Jameco – motors/props	\$20.90	Research & Design (R&D)
West Marine - motors	*\$130.00	Motors
Fiberglass	\$46.90	Floatation/buoyancy
Batteries	\$99.68	Bottomside Power
PIC programmer kit	\$157.00	Programming PICs
Pelican case 1300	*\$27.90	electronics container
ROS zoom camera	^\$3,195.00	main forward camera
Bolts/screws/brackets	\$30.15	structural support
Watertight housings (2)	^\$250.00 each	camera housings

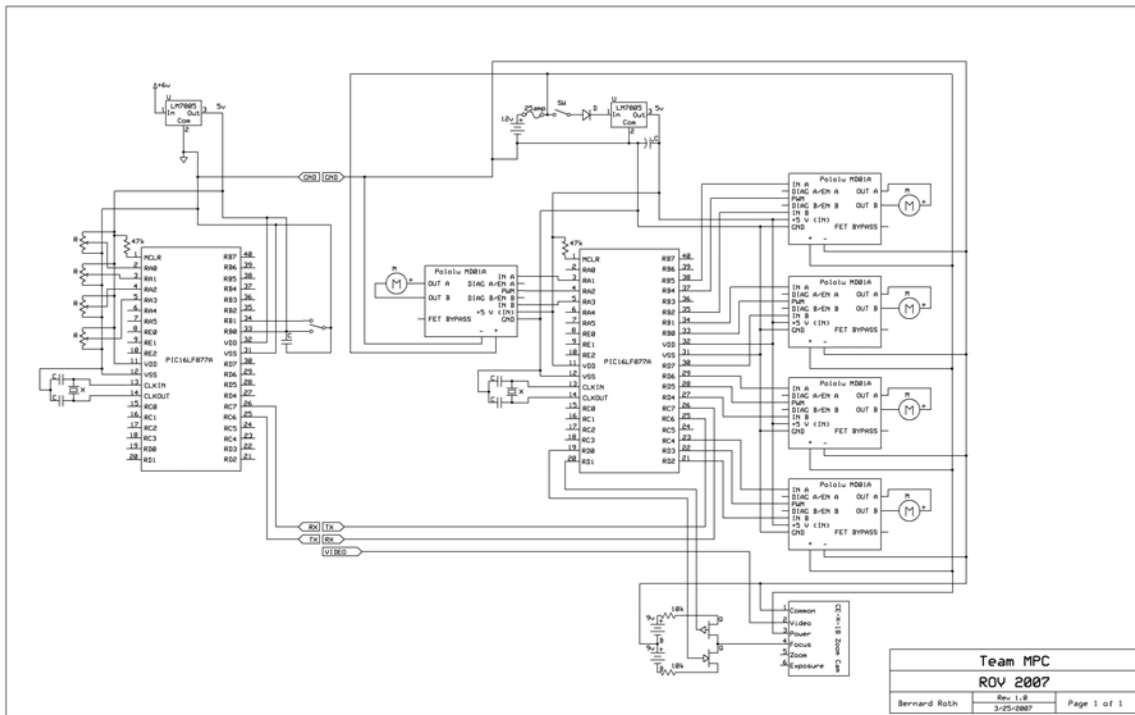
`Total expenses: \$512.53

*discounted prices

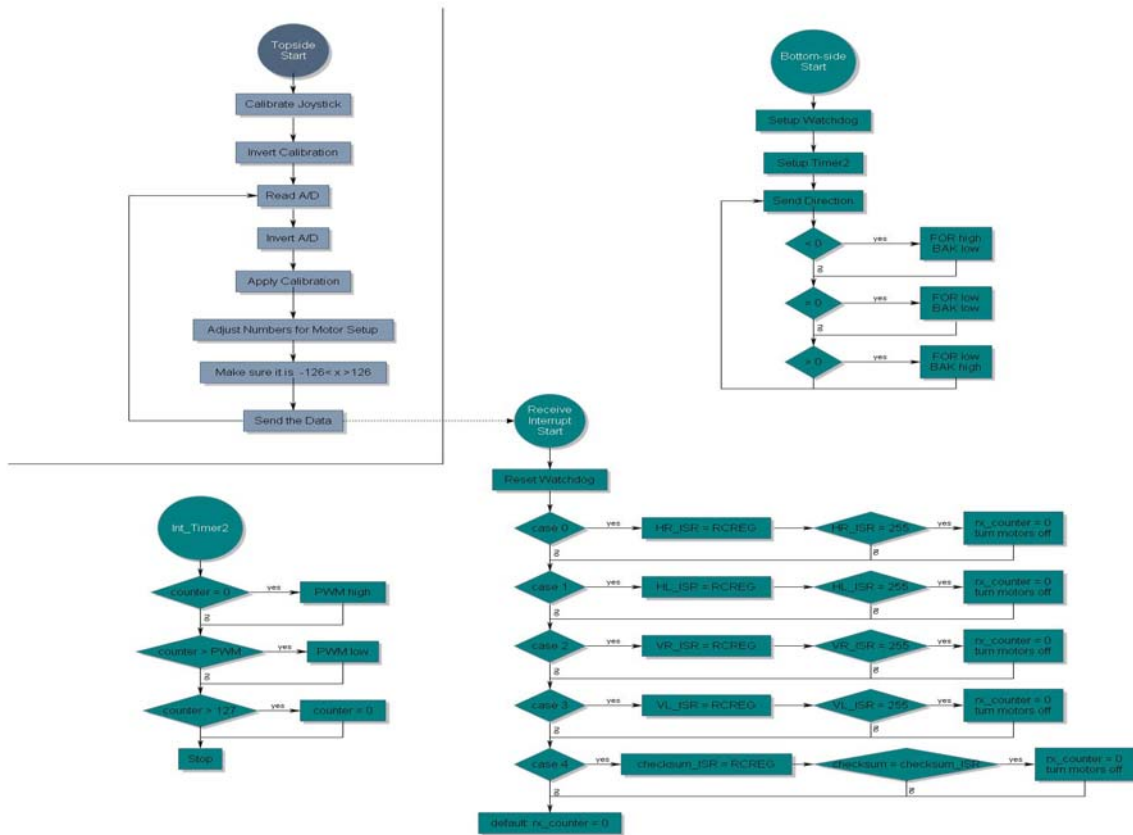
^donated parts

`does not include donated parts

Electrical Schematic:



Program Flow Diagram:



Acknowledgments:

The ROV club would like to thank :

*Remoter Operated Systems (ROS) for donating the zoom camera, wet link connector, and light housings.

*Instructors Jeremy and Trevor of the MAST 55 class for allowing us to use their class sessions to work on our ROV

*Light & Motion for the use of the pressure tank

Reference:

1. Human Adaptation to Arctic Zones

Emilio F. Moran

Annual Review of Anthropology, Vol. 10 1981 (1981), pp. 1-25

2. <http://www.saskschools.ca/~gregory/arctic/Aintro.html> - accessed May 31, 2007

3. <http://www.arctic.noaa.gov/faq.html> - accessed May 31, 2007.

Images:

1. Huddled Inuit - <http://www.pbs.org/wgbh/nova/arctic/amun-04.html>

2. Whale blubber -

http://www.nwfsc.noaa.gov/research/divisions/cbd/marine_mammal/kwnewsletter/oct2003.cfm