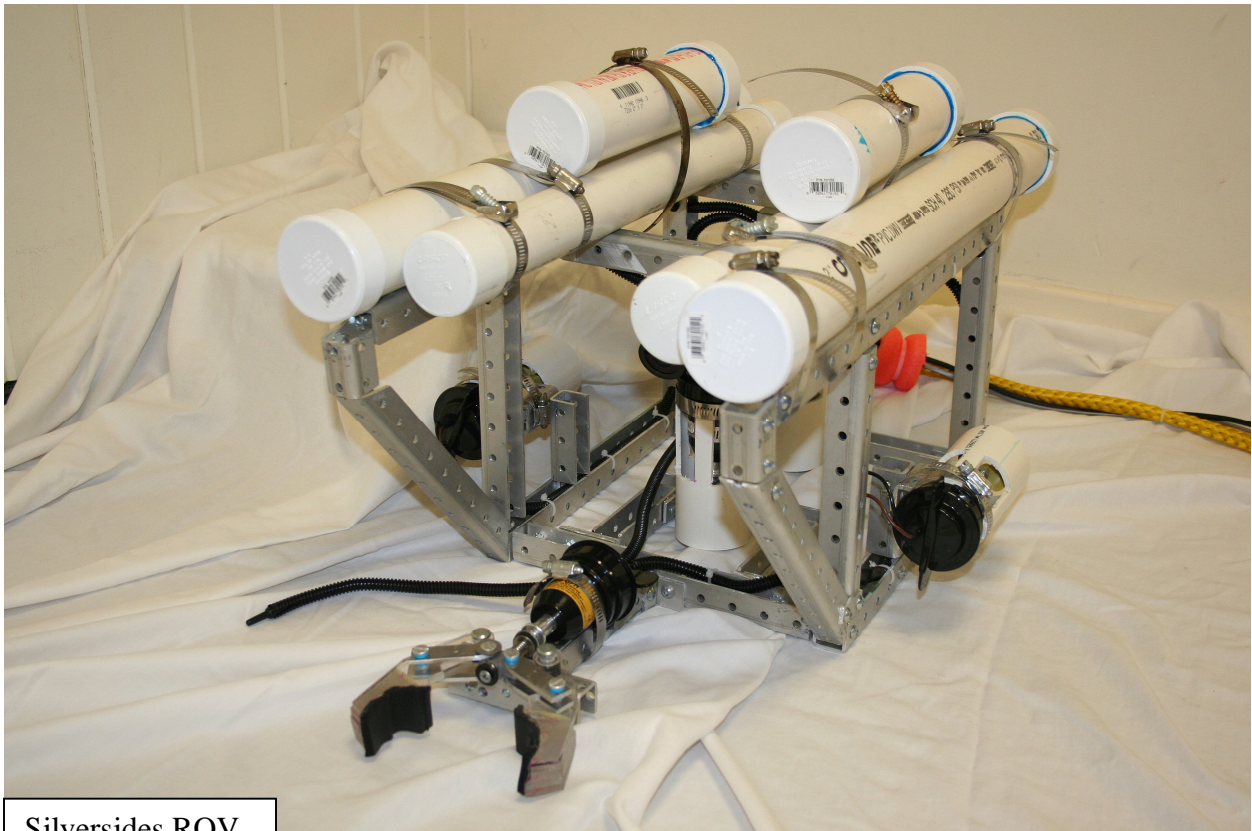


Running Ahead: Technical Report of Silversides

Silversides
Traverse City Central High
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Silversides ROV

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Abstract

The initial purpose of this project was to design and construct an underwater remotely operated vehicle (ROV) that would complete the tasks of the 2008 MATE competition. The work could be divided into three main processes: brainstorming and design, vehicle construction, competition and presentation. There was significant time spent in the fall making sketches and discussing general items such as shape, frame material and control system options. After finalizing the overall design in mid-winter we started our building process with the control system and variable speed. The frame was built attaching thrusters then our grabber, temperature probe(s) and buoyancy tubes were added last. The third part of this year's project was competition and presentation. Since construction, team Silversides has attended multiple competitions and demo events including MATE regional, Convergence Underwater Vehicle Design Competition, and SCI-MA-TECH famous speaker presentation. Design and construction took place after school in the Traverse City Central tech room and driving practice occurred at the local civic center pool.

Following in detail in this technical report will be discussion of budget, electrical schematics, and design rationale. Also described will be challenges, troubleshooting, lessons learned, and improvements.



Team Members: Matt Madion, Jacob Schaub, Brian Tiefenbach

Expense Budget

ROV

Camera	425
Aluminum Metal	125
PVC Pipe	20
Motors (5)	65
Joysticks (2)	40
Variable Speed Kits (5)	125
Wood Box	10
Clamps	20
Tether	14
Unit Directional on off switch	5
Plexiglas	15
Miscellaneous	50
Total-	914

Travel Expense

Driving from Traverse City to Grand Rapids	100
Flying from Grand Rapids to California	1,250
College Dorm Expense	827
Flying from California to Grand Rapids	1,250
Driving from Grand Rapids to Traverse City	100
Emergency spending	300
Total-	3,360

Total Expense 4,741

Donations

Karl Klimek and The Convergence Foundation	2,500
MATE Center	500
Total-	3,000

Electrical Schematic

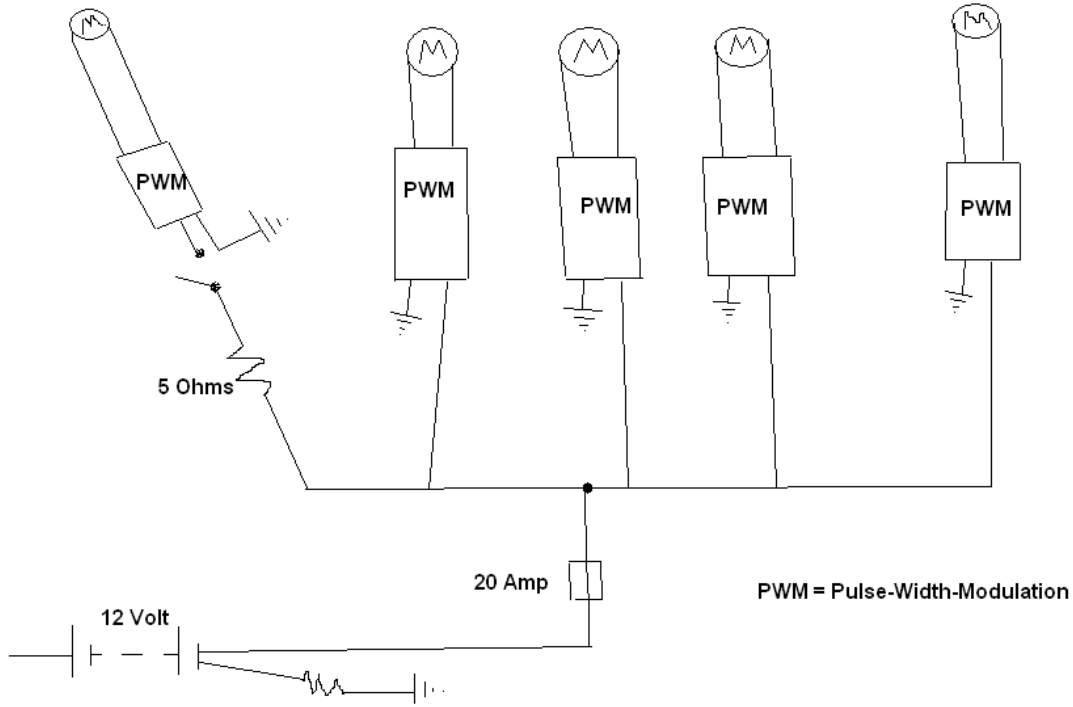
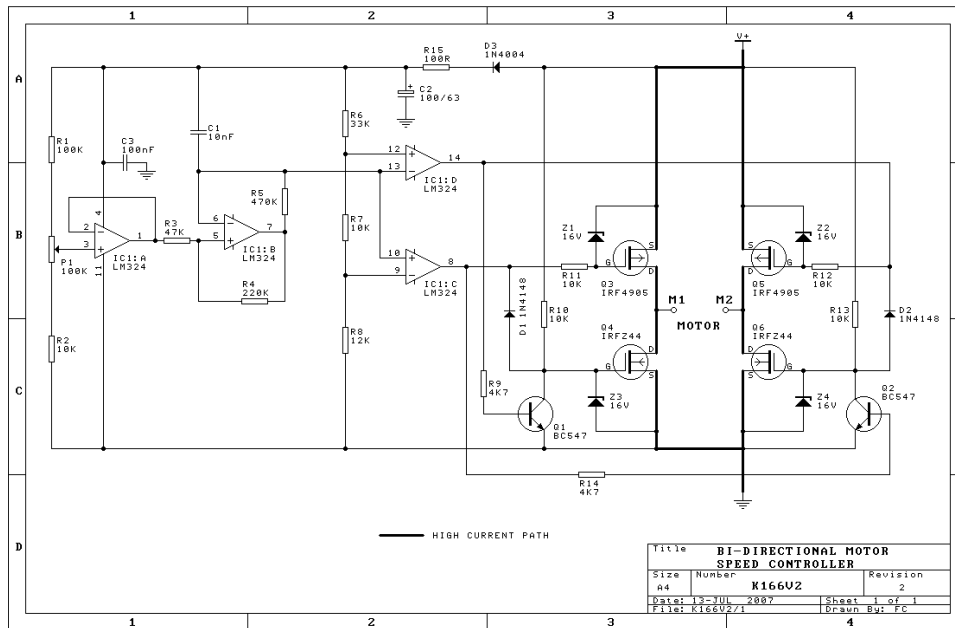


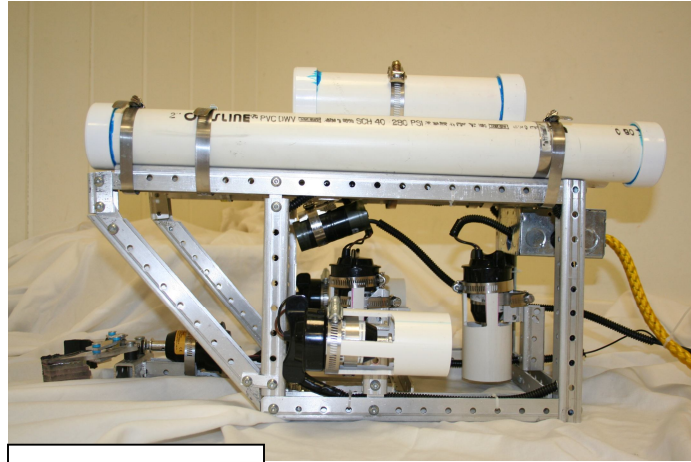
Diagram of Bi-Directional Speed Controller Kit



Design Rationale

Frame

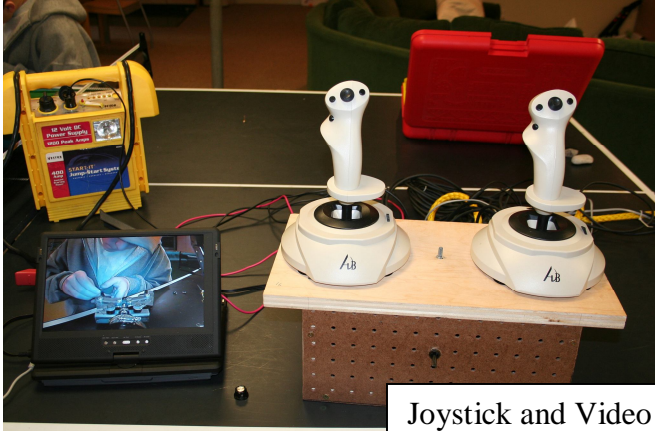
The frame is constructed from aluminum and takes the shape of a trapezoid. The short bottom length of the ROV allows the grabber to be placed close to the body of the ROV resulting in a more efficient control and a well-located center of gravity. Also, the aluminum was easily altered and cut during construction.



Side View

Control System

Running five marine motors, each one uses a potentiometer run to a Pulse-Width-Modulation chip. The four thruster motors are controlled by two joysticks, one vertical and one horizontal propulsion on each joystick. The motor for the grabber uses a separate potentiometer located in between the two joysticks. To allow the ROV to turn quickly, the longest width between horizontal thrusters was achieved. The pulse-width-modulation chips were purchased in kits rather than constructing separate parts to reduce cost and the joysticks allowed the controls to be focused on three items rather than five.



Joystick and Video

Camera

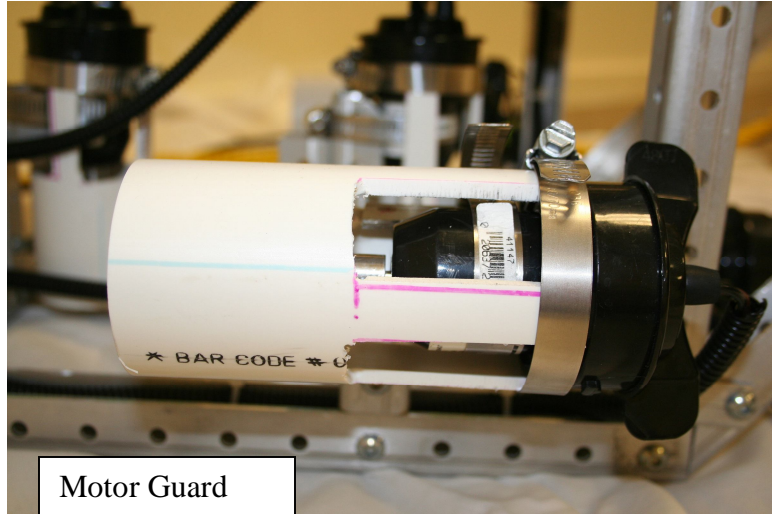
The most important and expensive feature on the ROV is the camera which was purchased from Lights Camera Action. It has a 3.6mm lens with a 1/3" SuperHAD color CCD and a visibility .03 lux with an infra-red capability. It also has 260,000 pixels per picture elements and the cable is 30.48 meters long and 5.08 millimeters in diameter. The camera weighs .5 kilograms and with the weight of the cable the camera weighs 2.04 kilograms. The operating temperature is -10 to 50 degrees Celsius with a RH 95% max. The maximum depth is 66 meters. The real use for the camera is for projects such as NASA laboratory research, nuclear utility inspections, oceanographic research, and global warming research. The high quality of the camera allows for use in many circumstances.

Thrusters

Silversides ROV uses five marine motors, one for the grabber and four for the propulsion. Each motor draws a max of 2.5 amps and with a 5 amp fuse and has a rating of 600 gallons per hour. With the pulse-width-modulation, the variance in speed allows full control of each motor. Each thruster motor had a three blade propeller.

Safety

To avoid injury to the ROV and to others, each thruster has a motor guard. Also, within the ROV, all exposed wires are covered by plastic tubing avoiding shortages and tangles.



Motor Guard

Grabber



Grabber

The grabber uses a marine motor connected to a 10-24 thread bolt. The bolt spins through a custom piece that moves two aluminum lever arms. Each lever arm connects to a side of the claw and the variation of length that the levers create cause the width of the claw to change. This was hand made by team Silversides.

Temperature Probe

The temperature probe used by the silversides was an ESU Battery operated digital thermometer. It reads in .1 degree increments and ranges from -23 degrees C to 60 degrees C. The team wired a longer Ethernet cord to the probes cord to make it long enough to reach as long as the tether.

Challenges and Troubleshooting

One challenge faced by team silversides was the movements and smoothness of the grabber. Since it was hand made and cut on saws by the team members the dimensions were not exactly perfect and did not run well in every circumstance. When the claw opened and closed to quickly the screw did not have enough power to turn it the other way. Thus it would seize up and make for timely mistakes. To fix this problem team silversides put washers and springs on each side of the screw so the claw did not open fully and would have enough torque to turn the other way. This process made the grabber work well but not great. Then they used tighter fitting bolts and nuts on the frame of the claw to ensure less tolerance in the movement. This made the grabber work extremely well and allow the team to pick up any desired object for the competition.

The grabber has a universal type of system. It allows for the claw to be slightly open or closed not just one of the other. This differs from pneumatics in that way. The use of variable speed allows team silversides to open and close the grabber as fast or slow as needed. Also its two claws are specified for grabbing a crab and the team build parts off the grabber to easily knock black smokers off the vent. It can be used for many aspects of the competition. In the other missions the team used a digital temperature readout device. It was a plastic covered thermometer used in fish tanks that read temperature to a accurate reading. A funnel was build to draw the water into the temperature probe so a more accurate reading was gained.

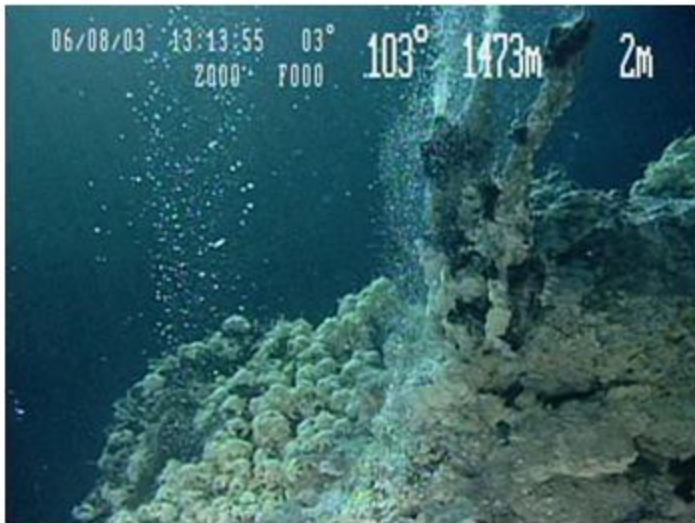
One improvement that could be made is a servo on the camera to allow it to move and see more objects. At this point the silversides are limited to there one view of the claw and body of water. With a servo the camera could move up and down or side to side and allow for a better view of the environment which is an important aspect and completing a specific task.

The team gained the skill of wiring and creating variable speed controllers. Also sauntering those board to potentiometers in a joystick. Also repairing burnt controllers and getting a better understanding of electrical aspects of joysticks and pulse width modulation.

One lesson learned is to spend more time in the water before the competition. It was vital to the teams success to even be in the water for a couple hours. If the silversides have had been in the water a longer time they would have easier completed the missions. The team could have learn more about the ROV by driving it in the water more and coming up with better ways to solve the problems faced in competition.

ROVs in the real world

One aspect the ROVs are used for is to gather and study Oceanic Hydrothermal Fluid. A Geochemist will use the high temperature fluids from these ridges to learn of the history associated with the hydrothermal circulation. Also to understand the processes involves as the cold water warms up in the crust and the high temperature fluid rises from the ridges. These ridges which are continuous volcanic chains are important to study and understand the effects of the fluids on the elements cycle in the ocean. It can also help learn about the short and long term global chemistries. The ROVs are loaded with titanium syringes, like a claw on our ROV. When it gets to the ridges the ROV can take temperature readings and samples to learn specific details about the fluids. This relates to the competition by taking temperature readings and samples in an environment that ROVs are needed.



Reflection on the Experience

This year in the ROV competition, our team felt like we accomplished a lot by making it to the International Robotics Competition. Last year we were a little unprepared which caused us to lose in the regional meet. This year we learned from our mistakes and used more of our physics knowledge to build a better ROV. Our goal was to win the Great Lakes Regional and qualify for the International Competition. Even though we took second place, we still qualified but we feel that we can still do well at internationals.

Acknowledgements

We just wanted to acknowledge all the people and companies who had to put up with our inexperience and lack of knowledge at the beginning of the year. We want to say thank you for giving us an opportunity to learn more about the ROV program. So thanks to...

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