S.S. SWRV

MONTEREY PENINSULA COLLEGE

TEAM LOBOS

TEAM MEMBERS

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James Ryan Goode
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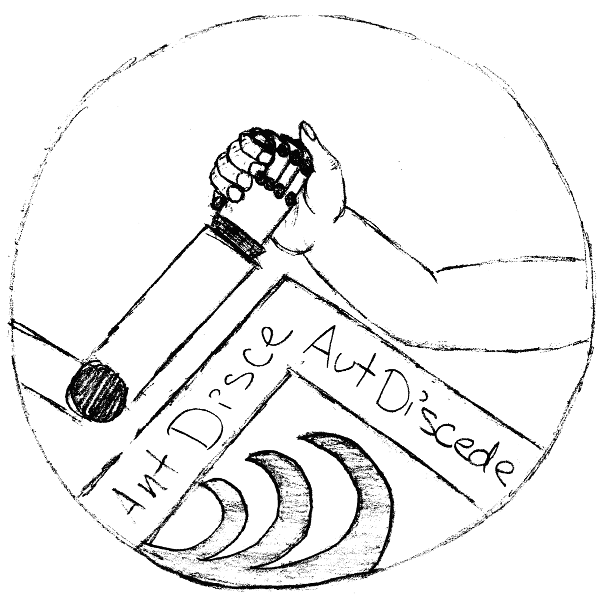
Abstract:

The Monterey Peninsula College Lobos team enters the 2009 MATE International ROV Competition after constructing and testing an ROV designed to participate in the simulation of a distressed submarine assistance and rescue. The mission parameters consist of surveying/inspecting the damaged submarine, delivering ELSS transfer pods, completing airline insertion and ventilation, and finally mating the vehicles and rescuing the trapped crewmembers. To this end, our team built an ROV per competition specifications designed to efficiently perform these operations. The vehicle was constructed by various team members strictly adhering to competition guidelines with special emphasis upon minimizing cost and commercially available components, while maximizing the utilization of spare parts, creative design, innovation, and most importantly, measures to ensure safety.

The relatively low budget required participation from all team members to contribute not only assembly time, but also programming, engineering, and design expertise culminating in operation and troubleshooting. All aspects were handled on-site with low overall monetary expenditure. The majority of materials were sourced from existing inventory or previous projects, primarily consisting of pvc pipe, electrical fuses/switches, bilge pump motors, foam and floats, fasteners, cameras, and wiring. The desire for advanced computer control led to the purchase of electronic components which were assembled into a control system. Overall the endeavor has been a resounding success, integrating team-oriented, low cost solutions with technological necessity resulting in an ROV fully capable of handling the mission parameters.



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Photograph(s) of your completed ROV

Budget/expense sheet:

Component Materials Cost of Materials
ROV PVC piping $0 (recycled)
Plastic protective mesh $16
6X 1100 GPH Bilge Pumps $0 (recycled)
Foam $0 (recycled)
Nuts, Bolts,and Screws $0 (recycled)
Rubber Bands $0 (recycled)
Lights $7
Waterproofed camera $0 (recycled)
2 professional underwater cameras On Loan

Tether 6X 18.29 meters long speaker wire $0 (recycled)
Net Floats $0 (recycled)
CPC connector pins $.72 each

Computer Controller Basic Stamp Homework Board $45
6X HB-25 Motor Controller $49.99 each
Parallax Servo Controller $35
Wires $15
Joystick $8.49
2X LEDs $.49 each
#1954033 PWR SPLY, DC-DC,480w $224.15
12X CPC sockets $1.05 each
Pelican 1510 Case On Loan
Emergency Kill Switch $0 (recycled)
Potentiometr $5.99
All wiring $0 (recycled)
Metal Box Housing $0 (recycled)
In-Line Fuse Wire $5.00
Key Switch $0 (recycled)
10-inch LCD Extension Cable $9.54

Backup (switches)Controller CAD cut out board $0 (recycled)
2X Kit 166 Motor Speed Controller $0 (recycled)
4X Switches On Loan
2X Potentiometers $5.99 each
Control Box $0 (recycled)
5X Barrier Terminal Strips $0 (recycled)
CPC Connector On Loan
2 Fuse Holder $0 (recycled)
4 Fuse Holder $0 (recycled)
CPC connector sockets $1.05 each
Fuses $0 (recycled)
Total All Materials $711.19 total

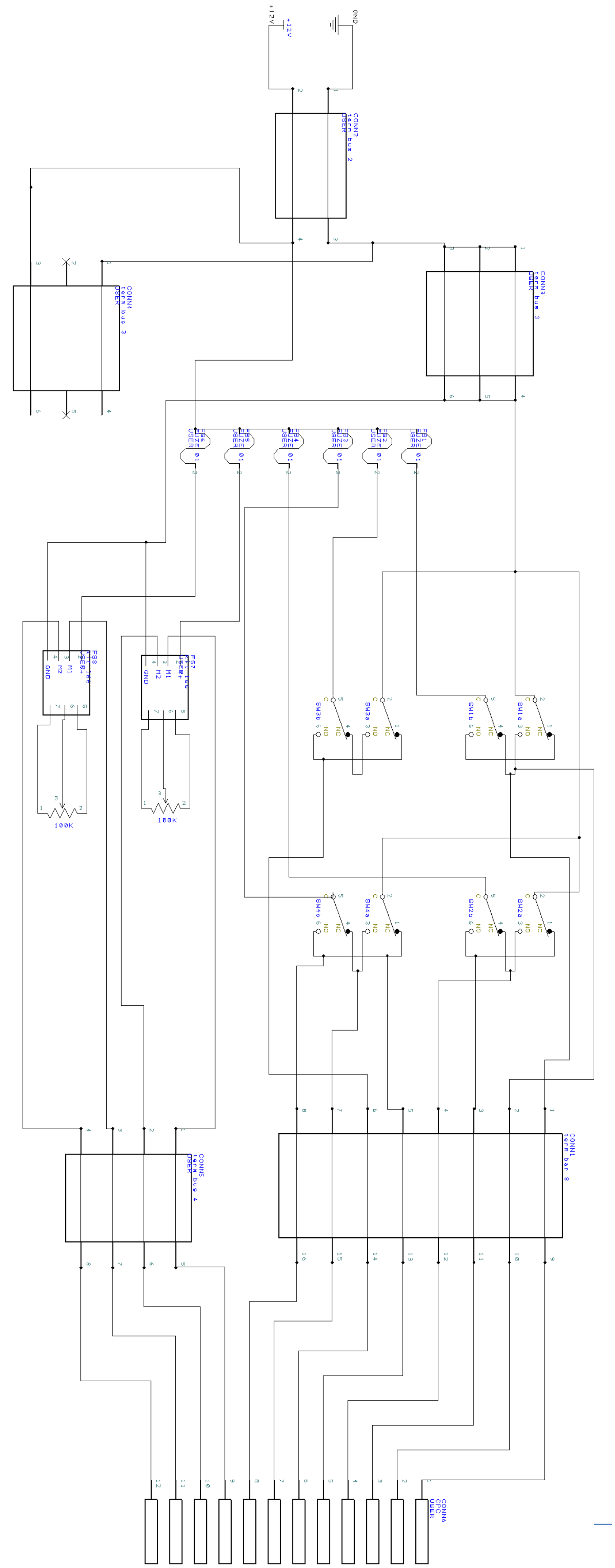
Travel/Housing Expenses Housing/Travel given $1000 by Inter Club Counsel $400 went to housing

Shipping covered by MPC Robotics Club personal account

Plane Tickets purchased individually by team members

Electrical schematics:

ROV backup manual control panel



ROV Main control system

Power

Anti reverse connection circuit

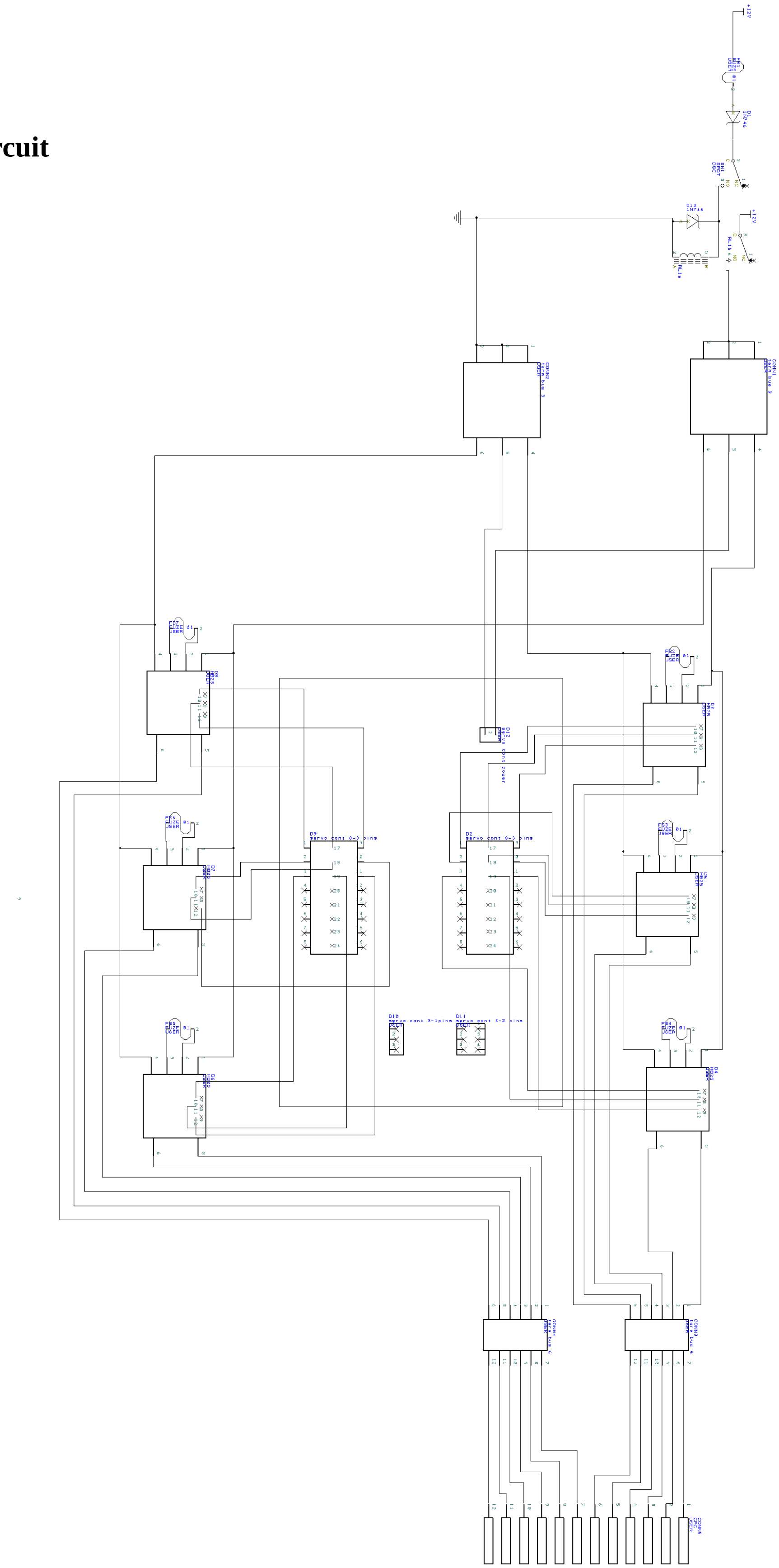
Keyed on switch

Homework board

Serial servo controller

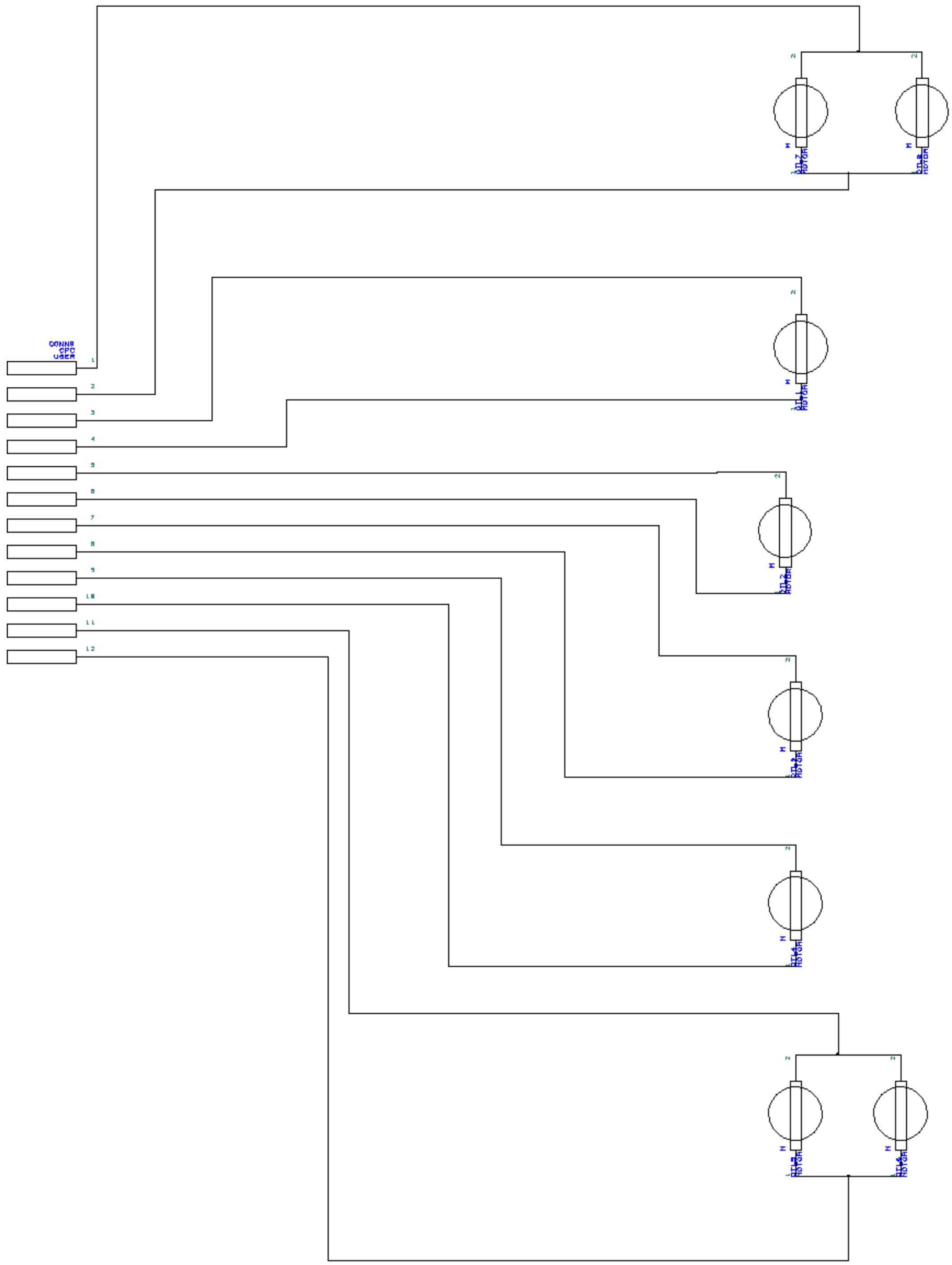
HB-25 Motor controllers

Connector to Tether



ROV Tether

And motors



Connections from controls to

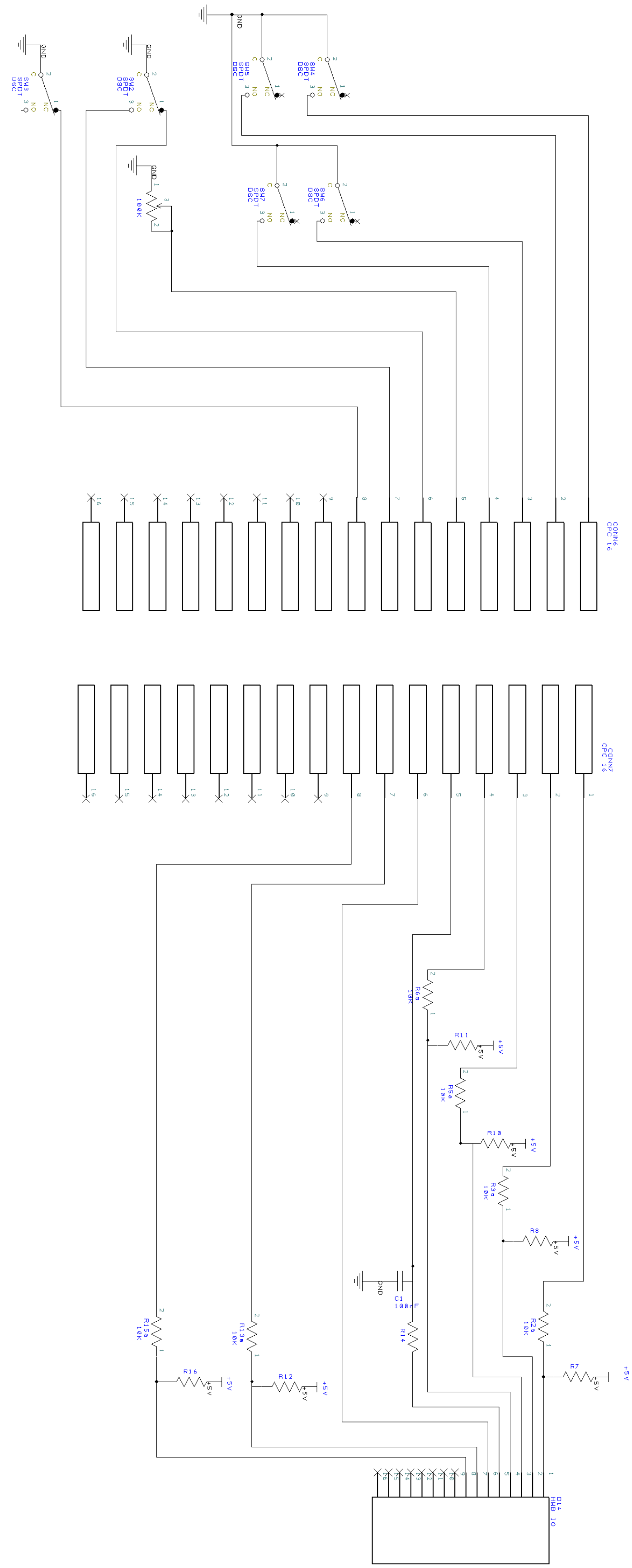
Homework board

Joystick

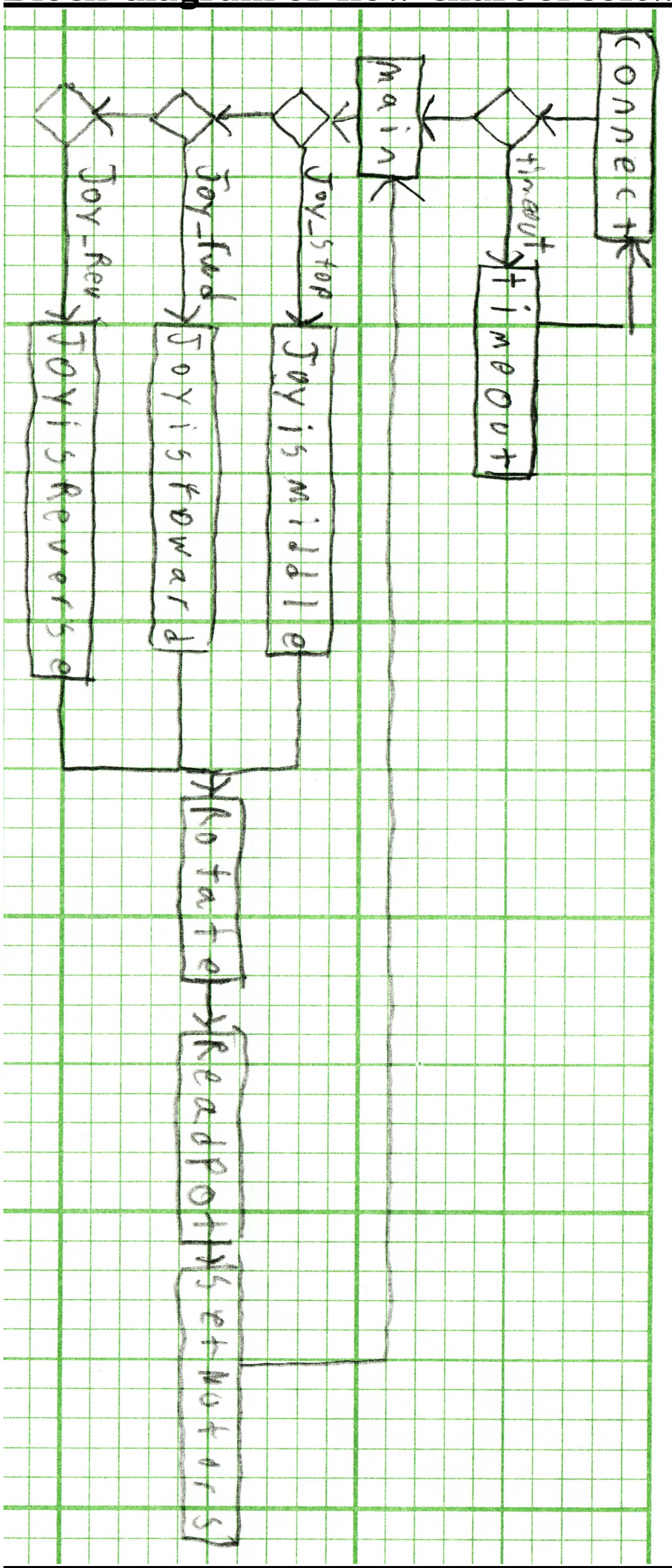
Potentiometer (depth)

right/left turn switch

and E-Stop



Block-diagram or flow-chart of software:



Design Rationale:

Mission parameters and specifications predicated the design process. Each aspect from frame design, maneuverability, accessory tool arms and attachments, control systems, etc contributes to solving a problem presented by this competition. Based upon these tasks, the overall size is small and compact for mobility yet powerful with eight motors sufficient to move the ROV underwater, lift ELSS pods, turn the hatch wheel, hover while simulating personnel transfer, and more. Four horizontal motors were placed in a rectangular pattern at an angle with the long axis which sacrificed speed and power yet contributed greatly to angular mobility off the x and y axes. Four vertical motors were used to facilitate efficient submerging/surfacing and lifting the 2N ELSS pods underwater while addressing pitch control. The original analog control system for the motors was bulky and difficult to use which led to the construction of a more modern computer based system offering increased precision and ease of use; the analog system was relegated to a backup/emergency role. In summary, this design and engineering process closely followed those guidelines presented by the competition committee, and overall design focused upon maneuverability, speed, power, agility, and the computer based electronic control systems to allow refined command of these attributes..

Challenge/Solutions:

Freddy B.: A big challenge that we faced was losing a key team member. We overcame this challenge by pulling together as a team and finishing what he had started. His primary function was writing the technical reports, shipping, physical and electronic schematics, and all other paperwork regarding the project. Our solution was to split up the work among team members and bring everything together as a whole.

Chris M.: One significant challenge the group faced was the bulky and difficult to use analog control system. Multiple control elements were separate and not integrated into a system easy to manipulate by one pilot. Additionally, the pilot found it difficult to instinctively move his hands from switch to switch without taking his eyes off of the camera monitors. Our solution to this was construction of an integrated computer based system. This system allows for relatively simple horizontal, vertical, rotary, and pitch control through the use of a joystick and three other simple devices easily used by the pilot.

Troubleshooting techniques:

Lights: When we constructed the lights we epoxied the whole light housing and wired LED lights with a relay and diode to prevent shortages from improper pole connection of battery. While presuming water tight seals, after testing in depths of more than 3 meters lights began precipitating at lens. Also when team members test piloted ROV with lights attached, the lights weren't properly sealed at battery housing and water seeped onto batteries. In the future a checklist of pre-dive procedures should be made in order to prevent water leaks in battery housing and lens precipitation.

Computer Control System: The computer control system had some problems but was successfully completed and operational. The trouble shooting ideas that were instilled or placed are; the whole system was protected by a relay circuit and diode to prevent shortages and system failures. In past competitions it has been stated that control systems especially computer, have been damaged or completely failed due to not protecting systems.

Tether management System: The tether was constructed and re-constructed many times in order to improve buoyancy and over-all design for the control system including the connections from tether to the back-up control box and finally to the computer control system. Terminal connectors were used for connections from tether to control boxes. Use of back probes and multi-meters were used to ensure proper directional flow of currents and connections. Also CPC connectors were installed to prevent lose connections and prevention of power loss or control during test piloting and during the competition.

Onboard Tools and Implementations: The over-all design of tools that are going to be used to achieve competition tasks are completed and operational. The spring loaded tubes that are used to turn hatch handle, had to be designed properly maintaining correct position (straight). Also all fasteners and nuts had to be loose for proper use of tools.

Summary: In summary our team is satisfied with overall design and construction of ROV-SWRV. While problems did arise and time was slowed, we did learn/gain valuable experience and overcame some tough obstacles.

Lesson learned and skills gained:

- James Vincent: “I learned that you always need a back up plan for everything.” “My gained experience is to have one extra part for every piece on the ROV. You never know what may happen.”

- Frederick Bensch: “I learned that it is much harder than I thought to keep things air tight under water.” “I gained experience in building a ROV all around. I became really good with motors and keeping the vehicle neutrally buoyant.”

- Ross Williams: “I learned a lot about how to solder better and how not to touch a hot soldering gun!” “My skills gained are all with soldering and circuit boards.”

- James Ryan Goode: “I learned that it’s hard to use an analog system to control a multifunction ROV.” “I gained a lot of skills in soldering.”

- Chris Mcdaniel: “I learned not to work on a metal table with a hot control board. You literally blow things up!” “I gained experience in building circuit boards.”

- Alex Hay: “I learned a lot about soldering wires together and to terminals. I also learned a lot about the chemistry of water and buoyancy in fresh and salt water.” “My skills gained are on circuit boards and electronics.”

- Chris Arumlzul: “I learned how math meets real life. Also, that some plausible ideas may never work.” “My skills gained are a lot of math and working it out to make the ROV better.”

- Ki Rosskopf: “Learned how problems still arise, even when potential problems are realized. Skills gained; Building lights and learning more about computer control systems.”

Future improvements:

Smaller tether- as of now we have 12 stereo wires, 3 camera wires, and net floaters as our tether.

We want to switch to a smaller tether that has less mass, more flexible, neutrally buoyant, and reduces drag.

Servo controller- we wan to go from 12 stereo wire tether, to a computer system that only needs 2 heavy duty wires and a communication line as out tether.

Air hose catcher- basically it is a mousetrap mechanism, that when the arm is moved it releases and 2 components come together to entrap the air hose for retrieval.

Pneumatic compensation system- we want to be able to counter the weight(s) that we will pick up. Also still be able to drop off the weight(s) and then compensate for the missing weight.

Hydraulic control system- we want to add a hydraulic control system so that we can use hydraulic manipulator arms.

Carbon fiber frame- we want to change from our current ½ inch pvc pipe to carbon fiber arrows. We believe that it would reduce the mass of the ROV by shrinking the amount of water held in the frame.

Sonar system- we have a sonar system, but it’s made to go over the top of the water. Pointing straight down and also when we used it in the pool, it refracted off all the pool surfaces making it useless.

Lights- we made lights to attach to the ROV, however they seem to have leaked. Also another part of the container wasn’t sealed right and water intruded into the battery housing. What we want to do now is create a watertight lends and housing. Then mount it to the top of our ROV overlooking the ROV’s arm.

Submarine rescue system:

DSRV Description Section: Atmospheric Diving Suits

Sources: Under Admiralty Services, Inc
http://www.nwrain.net/~newtsuit/technology/techmain.htm

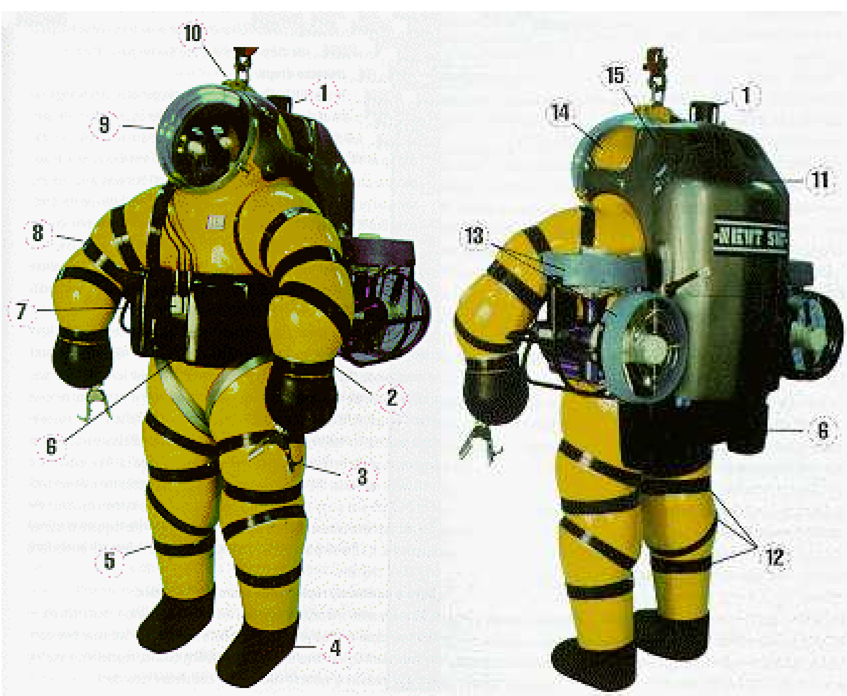
http://www.therebreathersite.nl/12_Atmospheric%20Diving%20Suits/Atmospheric%20Diving%20Suits.htm

OceanWorks International   http://www.oceanworks.com/atmosphericDivingSystems.php

Then and Now: Atmospheric Diving Suits Thornton, M Randall, R Albaugh, K Underwater Magazine March/April 2001

http://www.underwater.com/archives/arch/marapr01.01.shtml

Pictures courtesy of UAS, Inc



Pictures courtesy: OceanWorks International

Atmospheric Diving Suits have been in service for almost three hundred years with functions ranging from treasure hunting/recovery to submarine rescue, and most recently in support of the oil and gas industry. ADS systems are mobile, cheaper than traditional DSRVS, and can operate at depths up to 2500 FSW, depending upon the unit- recent testing indicates ADS can safely operate at over 3000 FSW; surface support is also greatly reduced due to non-saturation diving.

ADS systems are a great adjunct to ROVs especially in regard to submarine emergency assistance. By placing personnel directly onsite and in command, more information and options are available, and decisions can be made more quickly. While the ADS cannot carry as much payload as some ROVs or other vehicles, the unit does allow the pilot to assist in rescue operations and provide real-time, relevant informational updates to surface personnel. The unit is fully capable of performing most of the operations required in this simulation including ventilation, pod posting, inspection(the unit provides perception at depth), hatch clearing, etc and provides general assistance to other methods being employed. Due to near surface pressure inside the unit coupled with CO_2 scrubbers and other attributes, the ADS can remain submerged for extended timeframes, often over 6-8 hours, continuing to provide assistance where necessary to complete the mission.

Reflections:

Chris M. - The process of building the ROV was educational and required the acquisition of new skills which will be valuable to future employment endeavors.

Ki R. - Overall our time spent building, testing, and researching was managed well. Some problems that arisen could have been completed earlier so solutions and improvements could be made. We had a problem with lights and buoyancy. If we would have completed these two issues earlier, we could have had more time to test and complete more mission runs with our ROV-SWRV.

James Ryan- I learned that delegation of tasks and conflict of ideas among the group was an important cumbersome task to overcome.

Freddy B. - I really enjoyed the team work and our ability to work together to solve every problem that came up. Our first ideas almost always fell through, but we learned form our mistakes and overcame all our issues. Overall it was a fun experience and very educational.

Alex H. - I realized that building the ROV and participating in this competition and taking this ROV class doesn't stay at school. It took many hours out of class and at home to get the project completed. Dedication and perseverance were both a major part to this project.

James W. - I found that the class was an exciting experience and I enjoyed working on the ROV, also I was happy to put in my own hours.

Ross W. - It has been a lot of fun, I have learned a lot about circuit boards and wiring.

Acknowledgements:

Team Lobos/ ROV- S.W.R.V-

We would like to thank the following organizations and persons for funding, organizing, personal time, and dedication. We would first like to thank M.A.T.E for allowing us to compete in the 2009 ROV competition at the Massachusetts Maritime Academy in Buzzards Bay, MA.). Also we like to thank the Maritime Academy for hosting the '09 event. Deidre Sullivan and Jeremy Hertzberg at M.P.C.–MATE program for their support and guidance in construction and overall completion of our ROV-SWRV. We would like to thank the event planners for their help with our stay at the Maritime Academy, in the dorms and with providing us with food. The team members of "Team Lobos" for their individual time, persistent effort in each project, and for the overall completion of ROV-S.W.R.V. Trevor Fay at Monterey Abalone Farm for his donation of $100 and contributions. The Robotics Club at MPC for their help and commitment in completing the programming and with the computer control systems. Also the Inner Club Council (ICC) at MPC for their generous donation of $1000. Finally, we would like to give thank you to any

individuals who we did not mention, who contributed to the completion of our ROV- S.W.R.V. project.