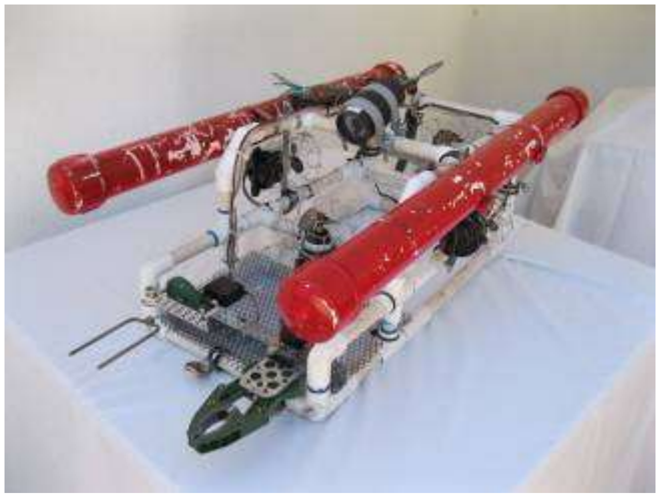
Triton Technologies

Palos Verdes High School - Team RED

Palos Verdes Institute of Technology

Palos Verdes, California



Front View of complete, intact Remotely Operated Vehicle: The Kraken

Team Members-Students

Anthony Bacalja: Head Mechanical Engineer, Michael Konrad: Human Resources,

Keith Kreiner: CEO and Head Engineer, Terren Krietzman: Mechanical Designer,

Kevin Ly: Public Relations, Scott MacDonald: Head of Props

Mentors/Instructors

Graham Robertson, Palos Verdes High School Instructor and Mentor

Peter Marshall, Palos Verdes Institute of Technology (PVIT) Mentor

Volunteers

Liz Bacalja: Parent, John Kuwata: Parent, Mark Krietzman: Parent

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Abstract

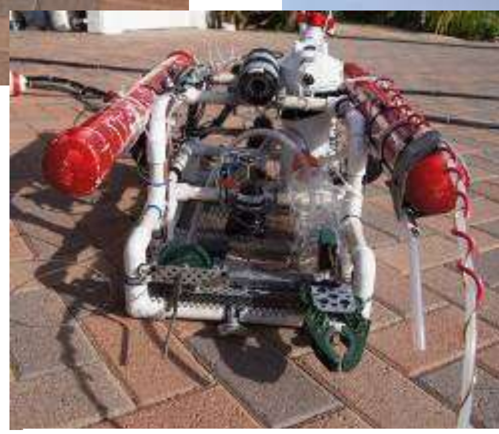
On April 20, 2010, the explosion on the *Deepwater Horizon* caused an oil spill that dumped an estimated 4,900,000 barrels of crude oil over the three-month period. Roughly 53,000 barrels per day were dumped into the Gulf of Mexico before it was capped. The effects of the British Petroleum (BP) oil spill are still felt today in the wildlife and the Gulf's fishing industries. Because of the BP disaster, Triton Technologies was tasked with developing an ROV to complete various missions simulating possible scenarios for an actual spill. The tasks include removing the damaged riser pipe, capping the actual oil well while "oil" is still spouting from the well, collecting water samples & measuring the depth, and finally collecting biological samples. Our ROV, Kraken, will complete these missions particularly using the mechanical claw and spinning fork attachment. The claw will hook the line onto the u-bolt, remove Velcro, and replace the hose line from the top kill manifold to the wellhead. The spinning fork will spin the valve to shut off the flow of the "oil." Kraken will bring sea samples to surface using magnets from disassembled computer hard drives. A unique aspect of our ROV is the use of both DC and AC in our control box. Kraken's design allows it to move easily through the water and perform the tasks with relative ease. We will demonstrate this by completing the tasks within the time limits.

The explosion at *Deepwater Horizon*

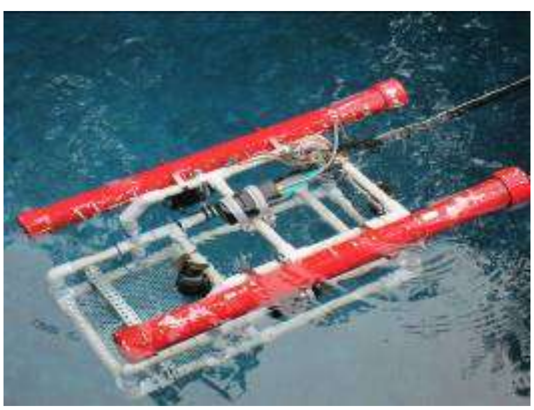
Photos of the Kraken

Front-side view of Kraken

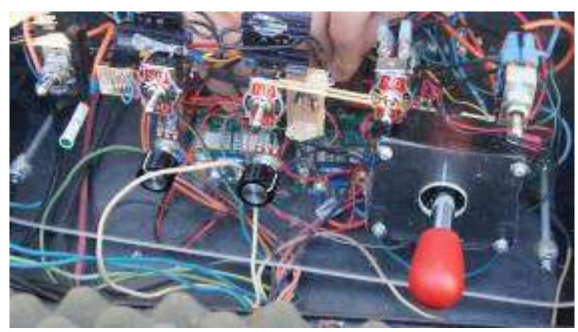
Rear-side View of Kraken



Head-on View of the Kraken



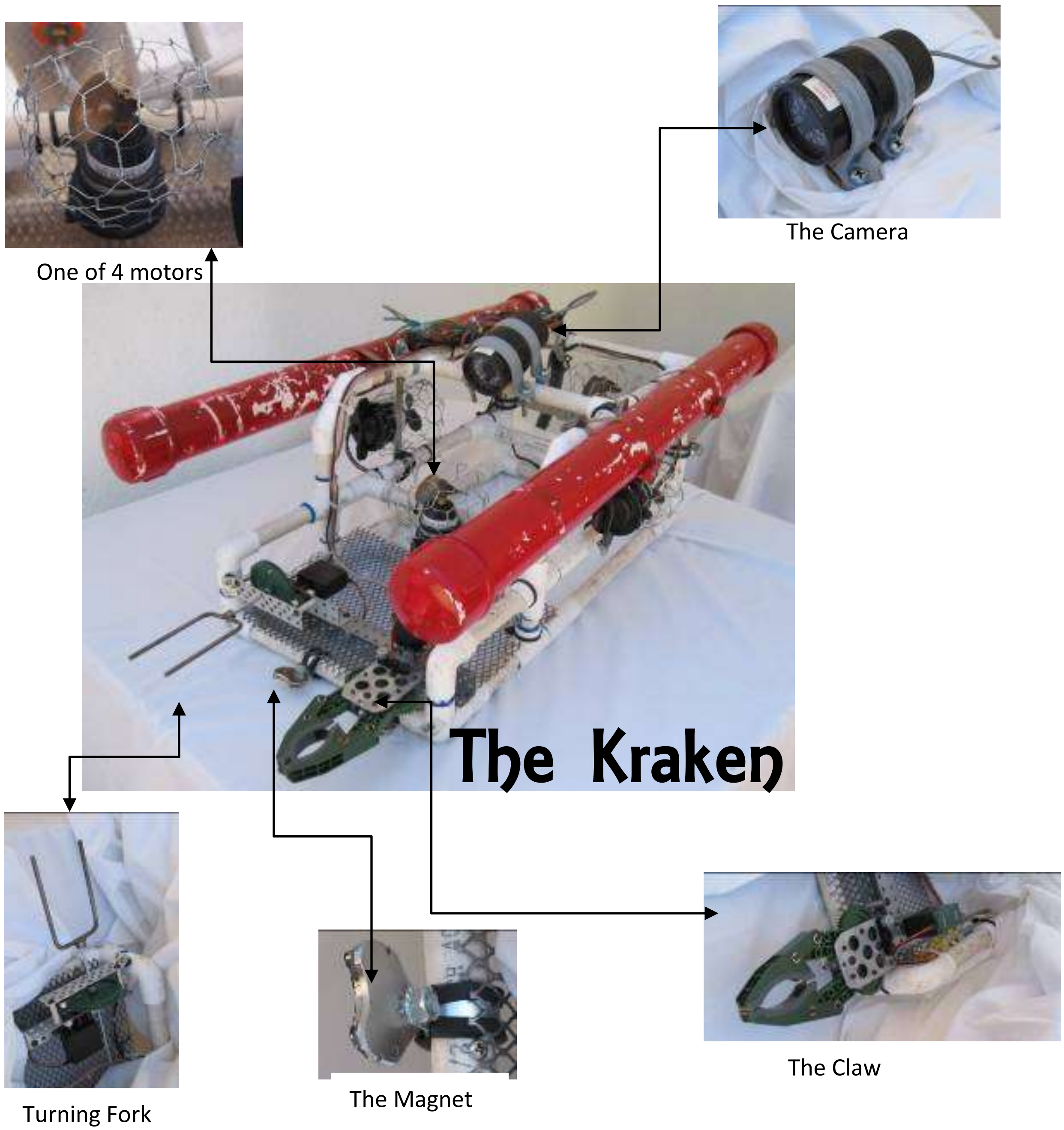
The Kraken in Action



Wiring the Control Box

Triton Technologies, from left to right: Michael Konrad, Keith Kreiner, Anthony Bacalja, Terren Krietzman, Kevin Ly, and Scott McDonald

The Kraken



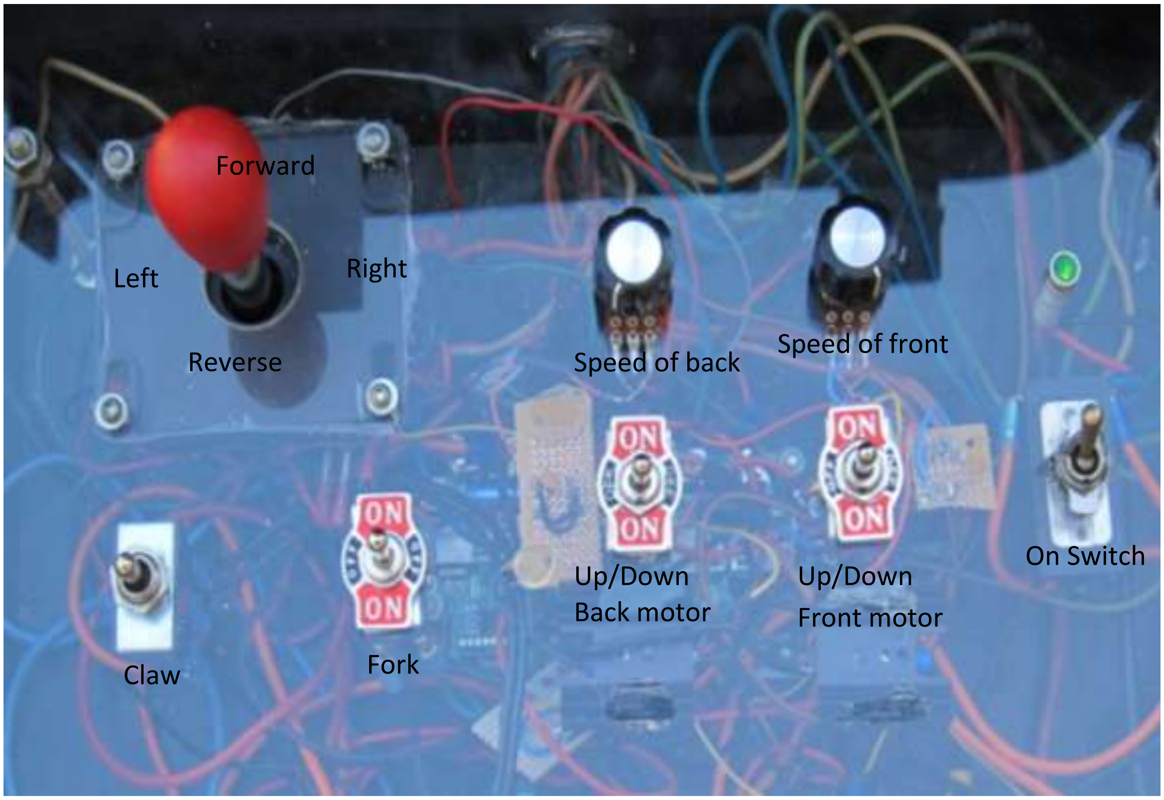
ROV Specs: **Approximate dimensions:** 83 cm length, 46 cm width, 28 cm height.

Weight: ROV alone: 8 kg. ROV with Control Box and ROV cable: about 25.6 kg

Safety features: 25 amp fuse, propeller guards, control cable with integrated rope

Special features: Up and down controls variable speeds

The Control Box



The Full View of
the Control Box

The Monitor

Budgets / Expenses

Purchased by 2008 ROV team:

- PVC Pipes $5

Purchased by 2010 ROV team:

- PVC Pipes $5

Purchased by 2011 ROV team:

- Propellers: $45
- Claws: $28
- Control Cable: $160
- Motors: $99
- Camera and Camera Cable: $190 + $121
- Monitor: $154
- Electronics: $58
- Controls: $13

Donations

- Control Case approximately $100
  Donated by Mark Krietzman, ROV parent

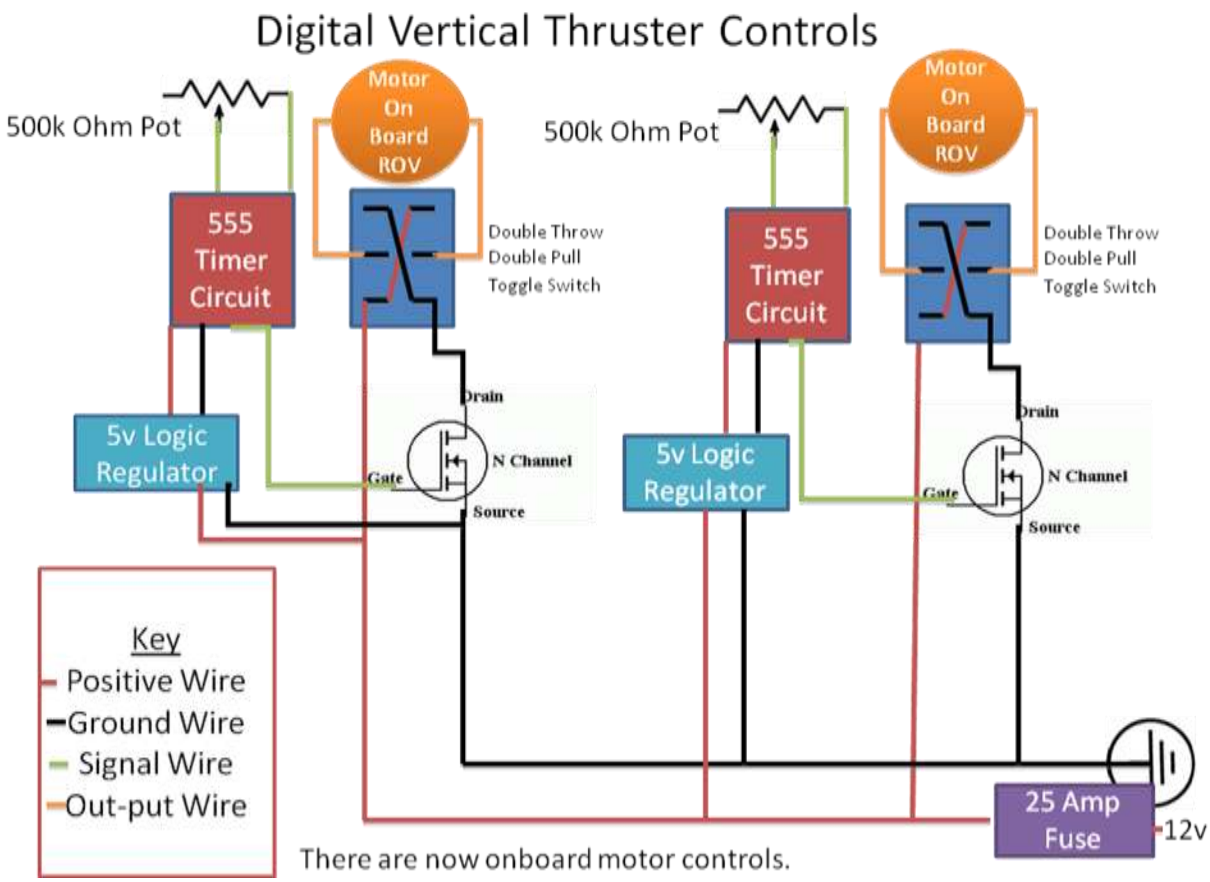
TOTAL of Purchased Items

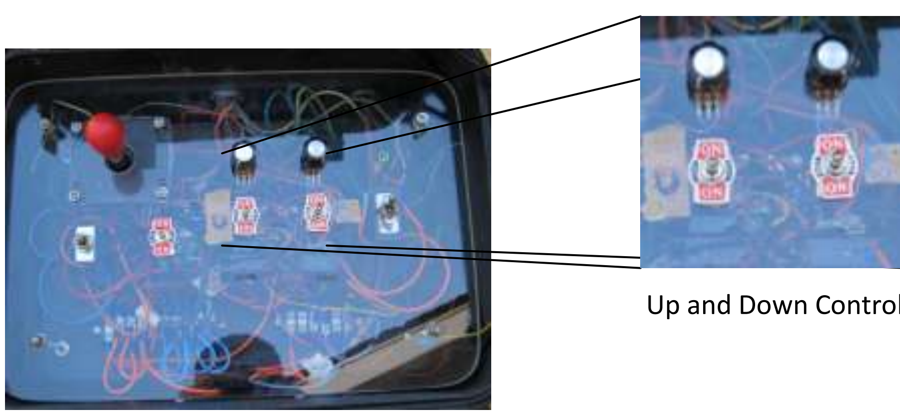
$878

GRAND TOTAL AND DONATIONS

$978

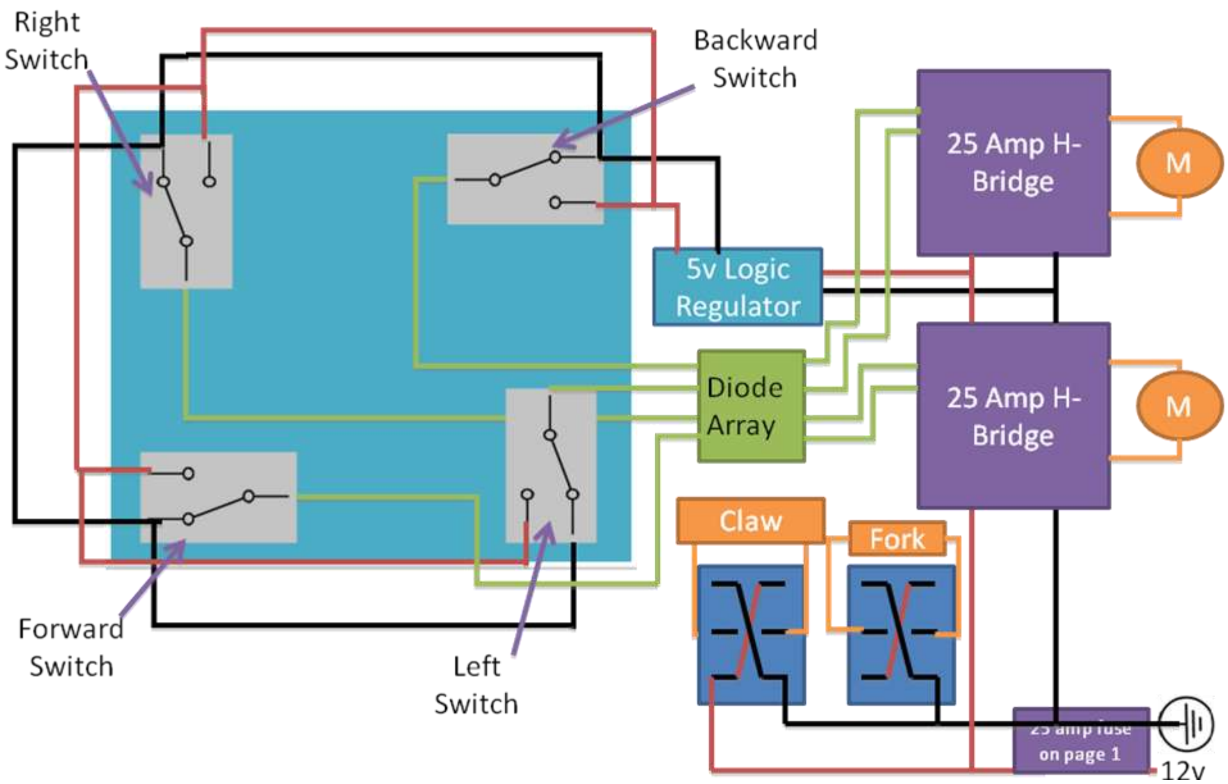
Palos Verdes High School ROV Electrical Schematics

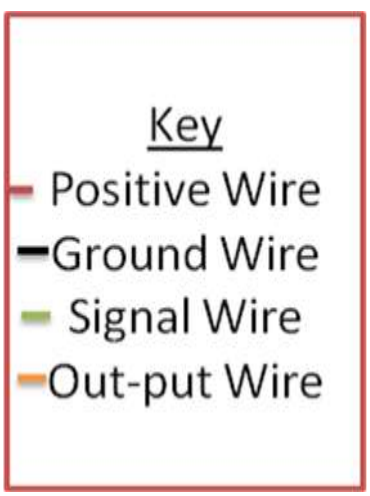


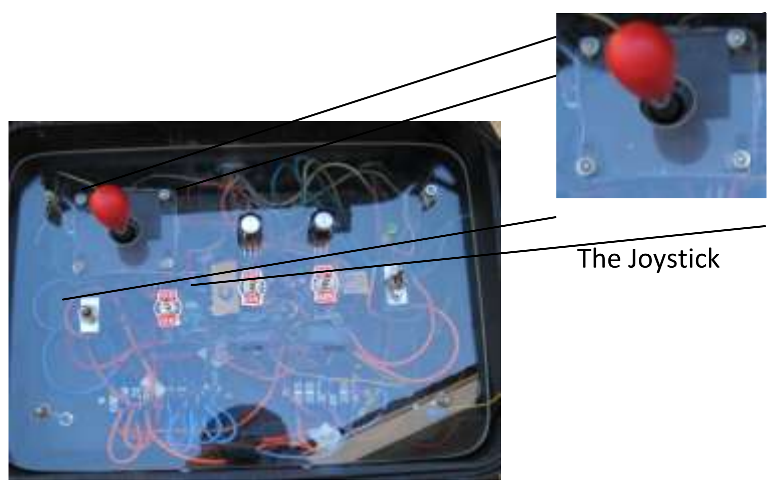


Up and Down Controls

Joystick and Manipulator Schematic

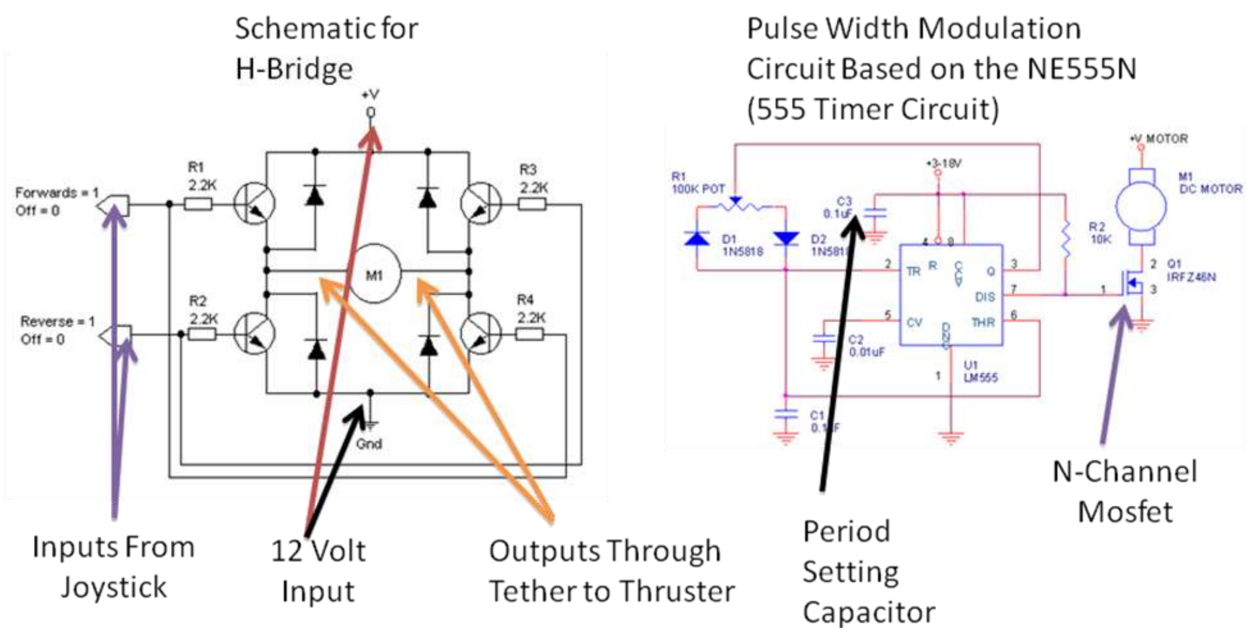






The Joystick

Individual Schematics For 555 and H-bridge Circuits



Design Rationale

This year the PVIT ROV Team wanted to create a ROV that could complete all the tasks of the competition while being a very versatile and unique vehicle. This being our second year doing the MATE ROV Fly-Off we knew what to expect and built a time line for the year, to get the ROV done while having an enjoyable experience. The ROV is all new this year and was built from everyday items (PVC pipe, Bilge Pumps, Shrink tubing) however the control box features a digital system alongside analog switches making it very unique. One of our goals was to create a whole new ROV while trying to save money by making all of the parts or finding them used. This year's ROV is equipped with a claw that can complete most of the tasks such as attaching a clip to the riser bar and lifting the T. On the front of the ROV there are two very powerful neodymium magnets salvaged from old computer hard drives to pick the sea life; magnets were a cheap and simple way to solve this task. To spin the valve we came up with a water proof motor that spins a "fork" to turn the valve.

The ROV safety features include a 25 amp fuse, covers for the propellers, and an integrated rope with the control cable. The fuse will blow if the ROV short circuits, preventing damage to the control box. The mesh covers over the propellers to prevent someone from sticking their fingers in the way of the propeller, making them much safer. The control cable has an integrated rope which gives the tether its strength and prevents wear on the wires.

There are four tasks to complete in the MATE competition, remove the damaged riser pipe, cap the oil well, collect water samples and measure depth, and collect biological samples. On April 22, 2010, the Deepwater Horizon wellhead exploded and oil leaked out. To stop the flow of oil from killing wildlife and damaging the gulf, attempts were made including the removal of the damaged riser pipe and the capping of the oil well. To calculate the damage done to the surrounding area, water and biological samples were collected. The MATE competition reflects these real world events in the form of tasks.

In task one, we have to attach a line to a U-bolt on the riser pipe, remove a Velcro strip from the pipe, then remove the riser pipe itself from the work area. To accomplish this task, we use a modified Vex claw which has been geared down for more clamping power, plus we opened the Vex motor and cut out circuit board to make it just a geared motor. The claw will attach a clip (with rope attached) to the u-bolt. Then the ROV will use the claw to pull off the Velcro and lift the pipe up while the team on pool deck gently pulls on the rope.

Prop building.

In task two, we have to remove the hose line from the top kill manifold, insert a hose line into the port on the wellhead, turn the valve wheel 3 complete times, and install the cap onto the wellhead. To accomplish this task we will use the claw to pick up the hose line and then use the turning fork to spin the value. The ROV will then use the claw to pick up and install the well cap.

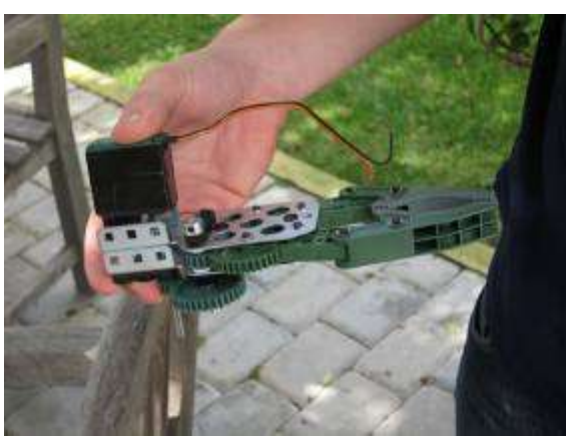
Pump used in task 3

In task three, we have to interpret a graph to determine the correct depth to sample, measure the depth, collect a water sample, and return to the surface. To accomplish this task, the drivers will look at the graph provided by the judges and then they will determine what depth the ROV need to draw the sample. A vacuum chamber will be used to collect the water sample. To operate it, before putting it in the water the chamber is emptied through a valve using a hand pump. Then to collect the sample, a solenoid on the other end is opened letting the liquid fill the vacuum. After the sample is collected the solenoid is closed to prevent contamination.

In task four, we have to collect one of each organisms: a sea cucumber, a glass sponge, and a crab. Then we have returning these samples to the surface. To accomplish this task, the ROV will use powerful magnets which we took from dead computer hard drives to bring the samples to the surface.

Payload Descriptions

For the competition we have three major tools. The most important one is the Vex claw we bought which we geared down for more clamping power. To power the claw we used a Vex motor but we opened it up and cut out the circuit board to make it just a geared motor. The claw is used for taking off the Velcro on the riser pipe and to bring down a clip to hook onto the u-bolt, and also for picking up the T and placing the well cap. For closing valves we have a geared down Vex motor to spin a U shaped piece of metal rod fork to close the valve. Two magnets were salvaged from some dead computer hard drives (to pick up the sea creatures).



Anthony showing off the claw before attaching it to the ROV

Vehicle Systems

The frame of the Kraken is constructed of PVC pipe. The thruster motors on the ROV are bilge pumps from West Marine which is one of our MATE's sponsors. The motors are wired to the control box. Brass remote control boat propellers are used for propulsion. The control box is a water tight box made by Doskoc. The control cable is approximately 23 meters and has 16 cores. The camera runs on 12VDC and runs through a separate line into a 22.8 cm monitor mounted in the control box.

Troubleshooting Techniques

1) Check master power supply (car battery) to make sure leads are connected to proper terminal.
2) Make sure control box is turned ON.
3) Check fuse inside of control box.
4) Check for broken of exposed wires.
   a) Search for shorts from broken or exposed wires.

For example, when one of our motors was not working, we made sure our power source was disconnected then proceeded to search for a broken connection or a loose wire. None of these were found so we proceeded to remove the motor to be replaced. Once installed, we reconnected everything and it was running as planned.

Future Improvement

Future improvements for the ROV would be to get bigger motors to spin our big propellers. Another mandatory improvement would be to attach another camera so that we could spread out our tools for the tasks. Also the camera(s) can be wired through the main tether. The stability and buoyancy of the ROV could be improved as well.

Challenges

One of the greatest technical challenges our team faced was the resulting video feedback that was caused by implementing pulse-width-modulation in the up and down motors to vary the speed. Unfortunately as the speed was increased on the motors, so did the feedback in the video. To solve this problem we filtered the video feed with a capacitor to lessen the amount of feedback.

A challenge related to the team was that the Palos Verdes High School-PVIT team split into two teams early on. Triton Technologies had a disadvantage after the split because our team had only six members. But the split provided friendly competition and both teams were willing to brainstorm ideas to contribute to the overall success for the school.

Teamwork

Triton Technologies managed this competition by categorizing the various components as individual assignments (portions that could be delegated to a single team member), and collective assignments (sections that required multiple people). The individual assignments included building the frame, ordering the necessary parts, configuring the camera and monitor, designing the control box, constructing the mission props, and preparing the poster board. Each of these tasks was assigned to one of the six team members and was completed individually.

The primary components of our approach to this competition required more collaboration amongst the team members. Collective assignments included attaching the parts to the frame, solving each of the missions, and testing the ROV. These tasks were carried out by all team members in a collective effort commensurate with their complexity.

The design was decided in a democratic fashion after several possible proposals were submitted. Within our team there was little dissent because our design effectively solves our former ROV's shortcomings. The frame was dry fitted as an individual assignment and the final version was constructed by the team.

The preliminary circuitry for the control box was engineered by Keith Kreiner. Troubleshooting and revisions were carried out by the team over the course of several weeks.

Keith working on the controls box

The tether and its wiring were completed as a collective assignment in the early stages of the building process.

The specific assignments were divided and delegated during the planning stage within the first couple meetings. Tasks were assigned based on each team member's specialty and ability. Our company followed a stringent schedule with the optimistic goal of completing a fully functional ROV within the first 12 weeks.

After meeting this goal we turned our attention towards addressing the individual missions and testing the ROV. We allotted 8 weeks to this end and were once again able to meet our deadline. The remainder of our time before the competition was spent creating the technical report, a collective assignment broken up into individual assignments. Through an effective combination of division of labor and collaboration, our company has created a fully functional ROV capable of completing the outlined missions.

Lessons Learned

After a year of working on the ROV team, the members of Triton Technologies have discovered many things about ourselves and each other. We learned how to cooperate and to work together in the most efficient fashion. We developed problem solving skills. We increased our overall knowledge of electronics, mechanics, and the physics of water. We have learned through experimentation which motors and propellers to use and the ideal shape of the ROV.

Many groups go through hardships during the building of any project. We had a problem when one radical side of our group decided to make the base of the ROV the shape of an octagon. Both the octagon side and what later became the current ROV team got into many arguments about the pros and cons of an octagon versus the conventional shape of a rectangle. The octagon team felt that the round shape of their design would make turning smoother. Our side felt that the rectangle shape would be sturdier. We felt that it was for the better if we broke up into two companies so that we can better concentrate on building. They separated and called themselves Palos Verdes Aquatic Corporation.

Even though the company with the octagon shape had separated from us, we still had a ROV to build. We had mechanical problem with the motors, the propellers, even the design of the claw gave us problems. We had to work together with the octagon company to brainstorm ideas and construct props. In a month, we had a ROV built.

Despite all problems we have learned much and prospered. The ROV building experience has increased our knowledge in engineering. We overcame a group crisis together and came out of it stronger than ever. The ROV is built and is ready to take on the mission tasks.

Michael overwhelmed by ROV problems

Reflections

Michael: Despite having worked in a group setting both inside and outside of school prior to this competition, I had never developed the skills necessary to effectively formulate and present an idea. There is little room for debate within an English or history project, but the combination of a difficult objective and intelligent individuals precipitated ideological clashes at every turn. These differences of opinion came to a head during the design process when our group was divided over the issue of the shape our ROV would take. The personal accomplishment I derived from this situation was the ability to construct, support, and how to defend an argument. This accomplishment transcends the competition and has proved invaluable in my other pursuits.

Kevin: After another year working with the Palos Verdes ROV team, I have learned much and developed many skills needed to survive in a workplace environment. I have learned how to work under pressure and to complete an assignment with an ever approaching deadline. As the technical editor and public relations it was my job to record all of what happened, put it into a concise and flowing format that explains the design goals, process, challenges and success that the team made. I was able to learn teamwork, delegation and coordination skills which will undoubtedly be important attributes to be successful in the real world.

Scott: One of my personal accomplishments I achieved during the construction and planning of our underwater ROV was the satisfaction I derived from working in a team environment where each participants' work complemented the rest of the team. Furthermore, having successfully constructed a functional ROV in the short period of several months with only a few hours per week resulted gives a sense of accomplishment for myself. Completing the building process for the props just as the ROV was nearing completion was an enormous accomplishment.

Anthony: I learned how to put a monitor and controls in a suitcase without it short circuiting.

Keith: I learned how to wire digital controls and how to use mosfets with pulse width modulation to make a variable speed motors.

Terren: I learned how to use a solenoid and a valve to build a vacuum chamber. One of the most important things I learned was working with the team even through difficult times.

Brainstorming with the other company

Michael and Anthony having fun

Acknowledgements

The Triton Technologies will like to acknowledge Palos Verdes High School for the use of campus and pool outside of regular school hours. We would like to acknowledge Mr. Robertson for running the PVIT program. We would like to thank Mr. Bob Wedeen for donating his time to giving us a lesson on electrical engineering. We would also like to thank our sponsor, West Marine, for their discount on the ROV's motors. We also would like to thank all our parents. In particular: Mr. and Mrs. Bacalja, Mr. and Mrs. Kashyap, Mr. and Mrs. Kuwata, and Mr. Krietzman. The Bacaljas: for their supervision of the team. The Kashyaps: the use of their pool and garage. The Kuwatas: for their use of their workshop and pool. Mr. Kietzman: for his donation of the control box.

Lastly, we thank the MATE Center in Monterey, plus the Mate Southern California ROV Fly-off supporters: Long Beach City College and Scott Fraser, Southwest Fisheries Science Center, MTS-San Diego. We also thank the Palos Verdes Peninsula Unified School District, Palos Verdes High School Booster Club, and Peninsula Education Foundation for their financial support.

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