PSU-UROV 2011

Portland State Univeristy enters into the annual MATE international underwater remote operated vehicle competition

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This is a proposal to fund a Portland State Univeristy team to compete in the Marine Advanced Technology Education Center (MATE) International Underwater Remote Operated Vehicle (UROV) competition. A team of undergraduates from Mechanical Engineering, Chemistry, Computer Science, and Physics are building a UROV to compete in June of 2011. The effort is sponsored by PSU, PSU Physics Dept, local buisnesses and companies, and private individuals. 2011 is the third consecutive year Portland State has sent a team to compete. This year's team is strong in computer programming and experience from previous years. The combination of hard work from the team and support from you gives Portland State a real shot at winning this year's competition.

Intellectual Merit: The design, construction, and operation of remote operated vehicles, and in particular underwater remote operated vehicles, is interesting because these vehicles are a gateway to an ever expanding frontier. Each new development in the technology behind these devices enables researchers to probe deeper into the ocean or further into caves and even underwater rescue and repair. ROVs and UROVs are ubiquitous becasue of their utility, whether a team is looking at the bottom of a boat as a part of a safety check or probing a black smoker under the pacific, they are doing it with an ROV because it's faster, cheaper, and safer to do so. UROVs can go places where manned submarines cannot, sometimes simply because the cost of deploying a manned submarine is too high.

Broader Impacts: This project is a learning experience for the team members and a chance to win some accolades for Portland State. Team members learn a variety of interrelated skills through this project. The realities of deadlines, interpersonal conflicts, and budgeting are learned, sometimes the hard way. There is a long list of skills that will be developed, ranging from soldering and machining components to deploying multi-processor closed-loop control systems. At the competiton, the team will see other team's solutions to the same problems and will be given the opportunity to network with leaders from both industry and academia.

Results from Prior Competitions

PSU-ROV 2010 *Total UROV cost: $2496.06*

Out of over 400 applicants for the combind competition classes, Portland Sate Univeristy ROV team for the 2010 season qualified for the Internation Competition and then sent 5 students and 2 mentors to Hilo, Hawaii where the team competed successfully. The 2010 ROV recieved 70/300 mission points and 216/500 total points, ranking 17th out of 26 international teams.

PSU-ROV 2009 *Total UROV cost: $481.10*

The Portland State University ROV team for the 2009 season sent 3 students and 1

mentor to Boston, Mass. where the craft did not pass the safety inspection due to unforseen electrical diffaculties. The craft recieved 0/300 mission points and an 80.67/500 total score, ranking 28th.

PROJECT DESCRIPTION

1 Introduction

Each year the MATE center hosts an underwater remote operated vehicle competition. There are two classes, one targeted at high schools and the other targeted at colleges and universities. The latter is called the Explorer class and is the class that PSU-UROV competes in. MATE publishes a list of missions and teams build UROVs specificially to complete these missions. MATE has not yet published the missions for 2011 but some componets are standard requirements (i.e. an arm). The competition will take place in a pool for controlled conditions; in the 2011 season this pool will be NASA's Neutral Boyancy Lab at the Johnsonville Space Center in Houston, TX. The UROV and all its control equipment must be powered from a supplied 48 volt DC power supply rated up to 40 amps provided by MATE. The team will be racing the clock, 5 minutes to set up, 15 minutes in pool for missions, and a 5 minute clean up. The operators will not be allowed to see the pool durring the mission run; all control of the UROV must be done through the sensors the team has installed in the UROV. The UROV and all topside control equipment must be powered from a MATE-supplied DC power supply that in standard for all competators.

2 Mission

MATE has not yet published the 2011 Mission objectives. Here is what is known:

- The 2010 mission objectives were published in late November, 2009
- Explorer class qualifications will take place in May of 2011.
- The mission will take place in June of 2011.
- The Competition will be in Houston, in the pool NASA uses to train astronauts to work in zero g, 40ft deep

It's really not a lot of information. The team is therefore working on things that aren't mission specific such as thrusters, gyroscopes, control loops, sponsorship, etc. However, this years Challenge will be operating in the pressure at this 40ft depth.

3 Design

Portland State aims to win the 2011 MATE underwater ROV competition in June. One of the biggest components of that goal is a world-class design. Experience last year has

convinced us of the need for certain changes. First, the bar we need to reach to win is to not only accomplish all of the tasks, but we must do this in less time than the maximum alotted. The craft must be fast, precise, and maneuverable. Two changes will achieve this: more powerful thrusters and closed loop control of the motion. This will allow the operator to quickly position the ROV, precisely as needed for the sensors and gripper, instead of constantly fighting to establish and maintain position against currents and forces from the tether.

Portland State aims to win the 2011 MATE underwater ROV competition in June. One of the biggest components of that goal is a world-class design. Central to this design are the best underwater thrusters available: 3 phase brushless motors running on 24 volts in an H-bridge configuration. The 24 volt power will be drawn from synchronous buck regulator boards that will be fed 48V DC. The regulator board(s) will be on the ROV meaning our tether will carry 48 volt power instead of some lower voltage, reducing power lost as heat. We have a design that uses 6 thrusters and gives complete control over the ROVs position in space to the operator; that is the ROV is capable of translation along the x, y, and z axes, and capable of rotation about the x, y, and z axes. Because we will have low power loss in the tether and in voltage level conversion, and because we are procuring the best available thrusters, we expect the ROV to have incredible speed, maneuverability, and thrust. The ROV will be controlled by a laptop computer running custom multi-platform software and will communicate with this computer using the RS232 serial protocol. The ROV will have an ARM microprocessor which will read and write to the controlling laptop, microcontrollers, and sensors. The sensors are one gyroscope and three monodirectional accelerometers, these sensors are externally powered and communicate with the ARM board via SPI. The microcontrollers are externally powered and communicate with the ARM board over RS232. They have 10bit analog to digital(ATD) conversion for mission specific sensing and about 8 pulse width modulated(PWM) signal pins which will be used to control the H bridges to control the thrusters. The ARM board will be running a closed-loop control system, listening to the gyroscope and activating the thrusters to hold the ROV in position. The controlling laptop will issue higher order commands in the form of vectors to the ARM board. The advantage to this scheme over a total control by the user scheme is it enables the ROV to hold position against a current or maintain a certain depth even as it takes on ballast.

4 Yet Another Section

5 Time Line and Management Plan

Meeting Agenda List (assumes that planned meetings start when the mission tasks are issued, MATE dates are identical to last year, and weekly Monday meetings):

- Pre-Nov 25th:
  - Generic Software and Electronics Design
  - Sponsorship Acquisition for Anticipated Parts

  - Thruster, Camera Testing
  - Pressure Chamber Design and Construction
- Nov 25:
  - General Software and Electronics update
  - Task-specific equipment design proposals assigned, equipment testing begins
  - Prop construction assigned
  - Thruster Vectors discussed
- Dec 6:
  - Final exams
- Dec 13:
  - Equipment testing update
  - Prop construction update
- Dec 20:
  - Props finished
  - Chassis basic design assigned (Basic design consists of a general idea of what the thing will look like, what materials to use, what size, etc)
- Dec 27:
  - Break for Christmas
- Jan 3:
  - Chassis basic design chosen, specific design assigned (specific design includes dimensions, materials, part #'s, etc)
  - Equipment finished, final chosen
  - Thruster vectors chosen
  - Specific software design assigned (I'm assuming that software will be an on-going process, like last year)
- Jan 10, 17, 24, 31
- Feb 7, 14, 21:
  - Project updates
  - Parts ordering
- Feb 28:

  - Product assembly assigned
- Mar 7:
  - Project updates
- Mar 14:
  - Final exams
- Mar 21, 28:
  - Project updates
- Apr 4:
  - UROV ready for practice runs (practice is on-going until shipment)
- Apr 11, 18, 25
- May 2, 9:
  - Project updates
- May 15th:
  - Regional qualifications
  - Technical Report assigned
- May 27th:
  - Technical Report due, sent to MATE
- May 30th:
  - Project report
  - Poster assigned
- June 6th:
  - Final exams
- June 13th:
  - Project update
  - Poster finished
  - Engineering evaluation practice
  - UROV shipped
- June 20th:

- Engineering evaluation practice

This timeline is very aggressive once the mission tasks are given. There's a little bit of slack given from mid Jan through Feb. I haven't been working with you guys on software/controls/etc, so I couldn't be very specific about the pre-Nov25th period.

Tell me what you think. Any suggested revisions?

6 Summary: Significance of proposed work

6.1 Intellectual Merit

6.2 Broader Impacts

BUDGET JUSTIFICATION