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 combined competition classes, Portland Sate University ROV team for the 2010 season qualified for the International Competition and then sent 5 students and 2 mentors to Hilo, Hawaii where the team competed successfully. The 2010 ROV received 70/300 mission points and 216/500 total points, ranking 18th 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 unforeseen electrical difficulties. The craft received 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 specifically to complete these missions. MATE has not yet published the missions for 2011 but some components 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 Buoyancy Lab at the Johnson 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 during 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 competitors.

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

The Portland State UROV 2011 will be a direct descendant of the two previous years' UROVs. Some techniques are being reused or modified. The tether from 2010 consisted of

low gauge copper wire and ethernet for communications. This years' is likely to be similar copper wire but the ethernet will be replaced with serial data for commands and a coaxial cable for video. If funds and sponsors permit, the UROV will have upgraded thrusters of the same type used in commercial applications. Two Teensy 8bit microcontrollers will be swapped for one ARM7 32bit processor. 8 single direction thrusters will be changed to six bi-directional thrusters and a clever placement of the same will give the 2011 craft control in two more dimensions. Perhaps the largest change is in control scheme. The 2009 and 2010 crafts were controlled directly by their human pilots. The 2011 craft will have a closed loop control system that will automatically compensate for changes in center of mass and for prevailing currents. The pilot will give instructions and the UROV will carry them out, no compensation by the human required.

4 Time Line

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

5 Management Plan

Portland State aims to win the 2011 MATE underwater ROV competition in June. 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 to do this in less time than the maximum allotted. 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 cur- rents and forces from the tether. Second, the team needs considerable practice time. The team must be prepared to accomplish all the tasks with military-like precision. The team must also practice for it's engineering evaluation. To en- sure practice time before the competition this year's team is making changes. One person is always designated the project manager. He or she has the final say in any argument, hopefully this clear structure will prevent long arguments from becoming distractions. A timeline has been written up and individual tasks are being assigned. This structure gives team members the ability to work on person-sized projects in a project-sized window. The hope here is that when meetings are held, each individual can present work they have already done, as opposed to long meetings where people argue about what they could do or want to do.