(UW)²TT

University of Waterloo Underwater Technology Team

www.eng.uwaterloo.ca/~UW2TT Volume 2 Issue 1 – Mar. 2007

How Sticky is Your GUI

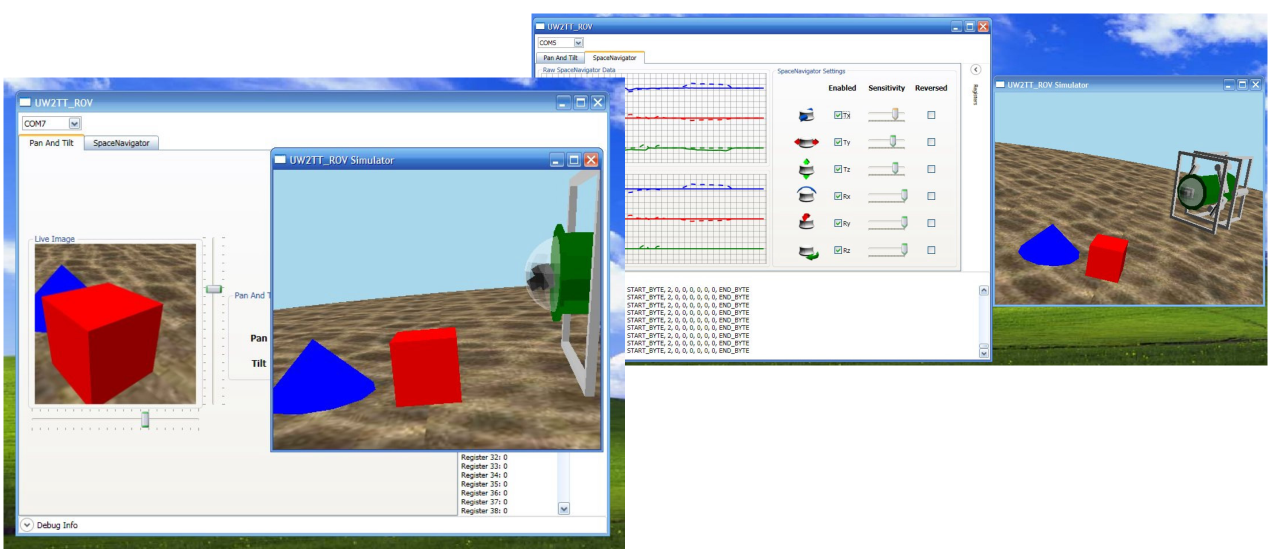
Development of the Graphical User Interface (GUI) and Vehicle Simulator

The Waterloo system encompasses four overall subsystems: Thrusters, Hydraulic Manipulator and Power Unit, Pan and Tilt Camera and Vehicle Sensing and Monitoring. These are each modular systems controlled independently with individual control boards. Communication to these boards occurs over a network through an Ethernet cable in the umbilical. A **Systech** serial server in the vehicle provides four RS-232 serial connections to communicate with each of the boards as well as a second Ethernet port for communication with the on-board **IQinvision** Ethernet camera. To communicate with the numerous boards and camera a single GUI is being developed.

Once complete the GUI will have a number of control panels, one for each subsystem. The control inputs for the **Space Control** steering device as well as the head mounted display will be processed by the GUI code and appropriate instructions sent to the subsystems of the vehicle.

Not only does the program act as a tool for controlling the actual system but it also provides a safe training environment for prospective pilots. Using a virtual environment, the pilot may maneuver the vehicle in a realistic manner. He or she receives the simulated video stream based on the vehicle position and the relative positioning of the pan and tilt camera.

Using the GUI as a training tool as well as a centralized control program greatly enhances the usability of the complete system.



Just Who is Flying the Vehicle?

The Team Focuses on Partial Autonomy for the 2007 Competition.

At the 2006 competition the $(UW)^2TT$ focused on our vehicle being "Highly Controllable and Highly Intuitive." To build on this philosophy for the 2007 competition we plan to incorporate partial autonomy.

Two levels of autonomy are planned for the Waterloo vehicle.

Autonomous attitude control
Autonomous position holding

Some autonomous attitude control exists on current commercially available vehicles. It is not uncommon for existing systems to have autonomous heading control; however, since these vehicles often do not have the necessary controllability, autonomous roll and pitch stabilization is not possible. By incorporating autonomous control over these degrees of freedom the vehicle will remain stable in the water, responding more quickly to disturbances from external flow or from the vehicle's umbilical. The current method for stabilization is due to the vehicle buoyancy. Buoyancy of most commercial systems is designed such that the vehicle is naturally stable (i.e. if the vehicle is upside down it will naturally right itself). The buoyancy of the Waterloo vehicle is designed such that the vehicle will be naturally less stable than current commercial systems allowing the thrusters to orient the vehicle in any direction. Since the Waterloo vehicle can be oriented in any direction through pitch and roll control, it is not constrained to orientations within the horizontal plane. The operator may choose to orient the vehicle such that it is perpendicular to a sloped surface for inspection or repair work. The operator could even choose to use the undersurface of an ice sheet as the virtual ground. We plan to use this feature during the MATE competition.

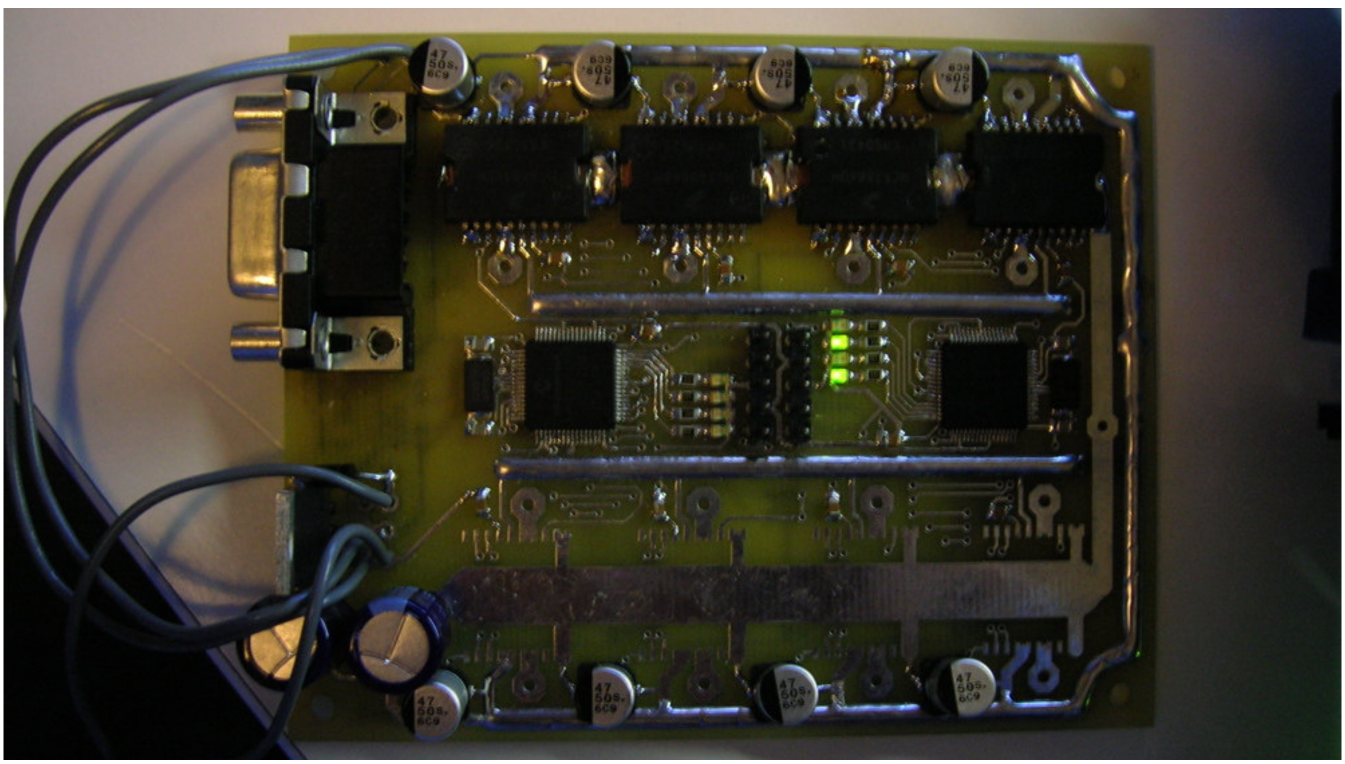
Currently when flying commercial systems, pilots have control over the force applied, by the thrusters, to that vehicle. When they release the control sticks the vehicle travels forward, carried by its momentum. The vehicle will also drift due to external flow when there is no input from the pilot. Autonomous depth control is less common than heading control on current ROVs; however, it does exist. The Waterloo vehicle is designed to allow for positional control in all directions through feedback from an acoustic positioning system and inertial measurement unit. By incorporating positional control, the pilot's inputs will no longer relate to the forces on the vehicle but rather the desired velocity of the vehicle. Thus with no inputs from the pilot the control processor will stabilize the vehicle in the current location, allowing the pilot to perform other tasks such as using the manipulator without having to focus on positioning the vehicle.

The theoretical groundwork to accomplish the two levels of autonomy exists and the Waterloo team has designed a vehicle capable of providing the required maneuverability to use as a proof of concept platform.

Heaves and Surges of Progress

Electrical Development Sees Leaps and Bounds of Progress

Significant progress has been made in the development of electrical components over the last few months: code to control the pan and tilt camera is nearing completion, the on-vehicle power board has been prototyped and board layout is being completed, and the thruster control board is complete. Since the team mission is to "Develop technology and engineers to advance the understanding of the off-shore and underwater environment," we strive to develop many custom systems. Our circuit boards are a great example of this. Design and population of the boards is performed by student members and fabrication of the boards is done through **Sunstone Circuits**. Over the next two months we hope to complete coding of these boards and integration of the complete system, producing a functioning vehicle for mid to early May.



Motor Control Board

(UW)^{2}TT would like to thank the following parties for their contributions and support to our team.

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