Glider Research & Development

Dr. Ralf Bachmayer is the Canada Research Chair in Ocean Technology at Memorial University in St. John's, Newfoundland and Labrador. In June 2010 he opened the Autonomous Ocean Systems Laboratory (AOSL) in the Faculty of Engineering and Applied Science, and is currently supervising five master's degree students and three doctoral students in Ocean and Naval Architectural Engineering from Canada, China and Iran on various projects. The lab is equipped with an inspection-class ROV, an unmanned surface vehicle and two Slocum underwater gliders are on loan from the Canadian Centre for Ocean Gliders in Victoria, British Columbia.

by Andrew Safer

Can you tell us about one of the projects you have been working on with your students?

Bachmayer (Pointing to a glider in the lab) The Hybrid glider came out of a discussion on ice profiling I had with some colleagues when I was working on AUV control and operations at the National Research Council's Institute for Ocean Technology (located next door to the Faculty of Engineering Applied Science). With regard to operations under the ice, one of the things you want to know is how thick the ice is, and often you also want to be able to go for distances of hundreds of miles. The current state-of-the-art in AUVs allows you to go for days or, in some exceptional cases, a week, whereas gliders have endurances that range from weeks to up to six months. This is possible since they travel at about .3 meters per second—a little more than ½ knot — so power consumption is very low, but in order to make headway, they also have to move up and down which creates their typical saw-tooth motion pattern. As a result, they can't perform level flight. I wanted to address this issue and one of my students, Brian Claus who came out of the Mechatronics program at the University of Victoria, took this problem on for his master's degree research. We started working on it in the fall of 2008.

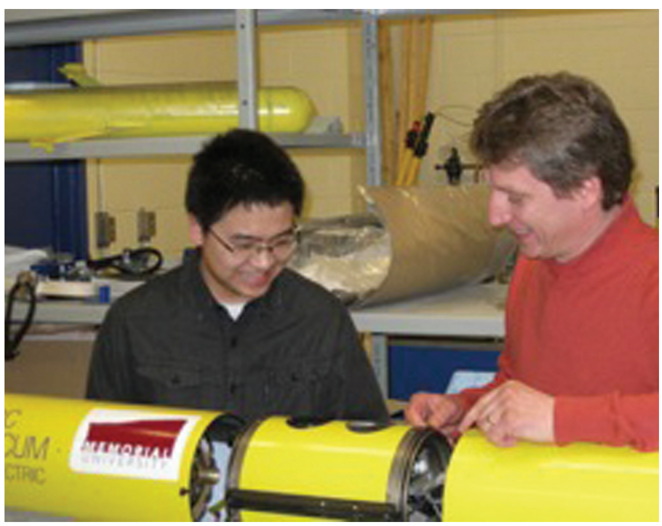
The main feature of the Hybrid glider is the propulsion module, which is optimized for low power consumption and high reliability. In order to achieve these two goals, all of the drive train components—the motor, gearbox, coupling and propeller—are selected with reliability and overall system efficiency in mind. We performed tests in the Marine Institute's flume tank, which allowed testing in a variety of realistic conditions, in the tow tank at Memorial University and finally at the Marine Institute's Marine Base in Holyrood. In January and February, we flew the glider in open water at a depth of 20 to 50 meters. From all these tests we determined that the drive is at least as efficient as a buoyancy-driven glider; it uses the same or less amount of power per distance travelled. Having easy access to those facilities allowed incremental development. In order to develop this unique glider capability, we have made shameless use of these facilities!

The other feature on this glider is an ice–profiling sonar, which is tuned to get reflections off ice. The sonar tells you the distance from the reflector. The plan is to have a glider criss-cross underneath an iceberg to get a rough shape estimate of what it looks like below the waterline. We worked with ASL Environmental Sciences of Victoria to get a sonar that fits into the glider, and the National Research Council developed the software to acquire data from it.

We haven't tested it under ice yet, but it gets consistent range measurements off the water surface.

Since the trials were successful, what's the next step?
Bachmayer There's an agreement with Teledyne Webb Research of Falmouth, Massachusetts to commercialize this technology.

What other considerations were you dealing with in this project?
Bachmayer The other problem we worked on is navigation. Power is the source of many challenges with gliders. There are severe power constraints so you cannot afford a very sophisticated navigation system like you would use on a large AUV—an inertial navigation system (INS) with a north-seeking fiber optic gyro. And because of the low power restrictions, there's very little hope of communicating over a long distance and at a bandwidth that's high enough to control the vehicle remotely. On a larger vehicle you could install an INS aided with a Doppler Velocity Log (DVL), which would tell you pretty accurately where the vehicle is, relative to your starting point on the seafloor as long as you stay within the DVL range of the seafloor. You could integrate accelerations and rates from a low power inertial measurement unit, but in terms of cost, power and ultimately accuracy it currently is not feasible for fully submerged operations, that is, without surfacing and the aid of GPS. You need to use "all your senses (sensors)" to figure out where you are, meaning that you have to utilize and combine other measurements you're acquiring along the way anyway. There won't be a single solution. What helps, is that if you're using the glider to support physical oceanography most of the time you're not looking for sub-meter accuracy as you would be if you were trying to locate a mine. So knowing the location within a hundred meters is adequate and in some cases, within 500 meters is OK, if you travel over distances of hundreds of miles.



What are some of the other pressing challenges in underwater vehicle development?
Bachmayer Besides power, communication and navigation, what's emerging now is autonomy. If you cannot have a high enough bandwidth to allow communication, you have to give more intelligence to the vehicle. We're just in the infancy of autonomous decision-making.

What about improving underwater vision?
Bachmayer In areas that are very structured like the offshore, you can have, for example, a CAD model and use acoustics or, if there is enough visibility, regular cameras, and combine all the data to produce synthetic vision — a combination of what you know a-priori about the environment and smaller subsets of what you actually detect and identify. Often the full scene can't be observed, but by comparing some of the key aspects with the CAD files or other representations of the environment, the vehicle would generate a synthetic view — a merging of virtual reality with reality.

What differentiates this lab from other AUV labs?
Bachmayer A large part of what we're doing is we're putting our systems through test loops in our tanks. We test them and focus on optimizing the design and then we put them in the ocean. Again, shameless use of the facilities! We already had a unique, world-class test-tank infrastructure in St. John's, but the Holyrood Marine Base provided the missing link between the tanks and the open ocean.