McGill Reporter

MAY 22, 2003 - VOLUME 35 NUMBER 16

Beasts with byte: Centre for Intelligent Machines

JAMES MARTIN | With the flick of a jerryrigged TV remote control, James Andrew Smith sends 25 kilograms of robot galloping toward the McGill Reporter photographer. The sproing-sproing of metal springs echoes around the hallway as the four-legged beast picks up speed. What promises to be a classic battle of man vs. machine (or at least "expensive machine vs. expensive camera") fizzles out as the robot harmlessly skitters to a halt six inches from the crouching shutterbug. This monster may not stop on a dime exactly, but it won't grind one into dust either.

"That was great, but I want a few more shots. Can we back it up and try that again?"

Judging from the grin stretching across Smith's mug, the question is pretty much rhetorical.

Scout II and Mechanical engineering graduate student James Smith
PHOTO: OWEN EGAN

The robot is Scout II, the pride and joy of McGill's Ambulatory Robotics Lab (ARL). Not much to look at? Perhaps. Scout's "guts" are a modified, off-the-shelf home PC. Its juice comes from D-cell battery packs, a specialty product aimed at the backyard MacGyvers who compete in Battlebots and Robot Wars. Its feet are rubber doggie chew toys. Much more than the sum of its parts, Scout II is a piece of history.

The ARL, part of the Centre for Intelligent Machines (CIM), holds the honour of creating the first autonomous legged robot able to gallop (that's when there are leading and trailing legs in both the front and rear of the robot) and half-bound (leading and trailing legs in the front, symmetrical leg movement in the rear). Although common in nature, these movements have long stumped the robotics world. The ARL has good reason to be chuffed about the achievement.

"Back in September, Stanford University announced that they were going to be the first ones to do it," says Smith, a PhD candidate in mechanical engineering who works on Scout II. "I figured, 'Well, we can't let that go!' so we decided we'd try to do it first.

"In January, that's exactly what we did."

An ARL team took Scout II to Kyoto, Japan this past March, and the four-legged critter wowed the masses with its galloping prowess. (Scout can also "pronk," the official term for the strange propulsion exhibited by llamas and lovestruck cartoon skunks.)

"It was fun because we could demonstrate the differences between what we're doing," says Smith, "which is relatively simple with one motor per leg, and the traditional Japanese approach of having lots of complicated motors -- like the Sony robot dog, which has 20 motors in its entire body.

"And the dramatic part is that Scout just went a whole lot faster than those other robots."

Scout isn't the ARL's only success story, either. There's also RHex, a speedy six-legged stair-climbing marvel (no small robotic achievement) which uses rotating half-circle limbs to pull itself up from stair to stair. And work is already underway on Aqua, RHex's submarine equivalent which will be able to move freely from land to sea.

These accomplishments aren't just big news for a small circle of robot aficionados. Funded in part by the U.S. Defense Advanced Research Projects Agency (the main R&D arm of the U.S. Department of Defense) and Defense Research and Development Canada, the ARL's overarching goal is to create robots that have specific use in the outside world. Whether it's direct military application, or use by police in situations too dangerous for humans (such as bomb-disposal), ARL robots are designed to get out of the lab and get to work.

Professor Martin Buehler, head of the CIM, says the lab focuses on "achieving unprecedented mobility in legged robots based on some principles of mechanical simplicity, dynamic stability, and biological inspiration." But -- and this is a big but -- the robots must always serve a larger purpose.

"If it doesn't have any utility for humankind," Buehler adds, "if it doesn't do something useful, like save lives, or make lives easier, then we're not doing our job. Then it's just a cool research toy in the laboratory."

Which isn't to say that the ARL isn't a fun place. (After all, the researchers do keep a complete set of Junkyard Wars videos on hand for inspiration.) "There's a fun project going on in every corner of the lab," admits Buehler. "I stop in for five minutes, and come out three hours later!" But the real action, and satisfaction, happens when the teams put the robots through their paces on top of Mount Royal or Mount St-Hilaire, or next to the Lachine Canal. Or possibly in the Lachine Canal.

Buehler and company videotape all their field tests for later review and study, and the lab's website (www.cim.mcgill.ca/~arlweb) serves as a "greatest hits" showcase of past triumphs -- the operative word being "hits." These robots don't have it easy. Especially poor little RHex.

See: RHex tumble OS-over-teakettle down a rocky cliff and hit the bottom running! See: RHex blaze a trail in the underbrush! See: RHex climb over logs as it dashes through a forest! See: RHex tackle yet another rocky cliff!

(Buehler admits the obsession with sending RHex over rocky cliffs came about on a day when the team's mechanical engineer didn't go along for the hike: "He would have strangled us if he'd seen us torture the robot that way!")

"But we're not in the business of making jawdropping videos," Buehler adds, "although we love doing that. The jawdrop comes from showing robots that, for the first time, can do something that no other robot has ever been able to do."

Of course, working for the greater good has its perks: "We routinely get to risk a lot of expensive equipment."

This no-holds-barred approach to field-testing made an immediate impression on James Smith when he first came out to interview at McGill after studying at the University of Alberta. "The guys running the RHex project took me on one of their field trips," he remembers. "They put a bag around the robot, threw it into the St-Lawrence, and made it swim. I'd never, ever seen anyone take a lab robot and just chuck it into water like that: 'Here's $20,000 worth of electronics -- let's see if it swims!' That commitment to testing these things outside makes it really fun."

(And, yes, the robot did indeed swim. Sure, it eventually tore its protective bag and took on a bit of water, but it swam all the same.)

Smith recalls another time when a team took RHex to San Antonio for the researcher's equivalent of meeting the in-laws: strutting their stuff in front of sponsors. The team was sequestered in a shack on one side of the testing ground. They were remotely operating the robot, relying on what they could see through the robot's camera without being able to actually see the robot themselves. "They were told to follow a specific path," he says, "but immediately got lost and turned into a pile of test equipment to be used for future obstacle courses. So they managed to go through this completely unstructured pile of rubble, eventually making their way out and into a forest -- where a tree fell onto the robot. The project sponsors were following behind and they figured, 'That's it. Game over. It ain't going anywhere.'

"Meanwhile, the people in the shack controlling the robot had no idea what was going on, they just knew RHex wasn't moving forward. So they decided to pull it back a little bit, then push it ahead, then pull it back -- and eventually they got one of those circular legs to whip all the way around the robot, grab a hold of the log which had fallen onto the robot, and snap it. And away it went. It was at that point that the sponsors began to realize that this was something different, that this was something they hadn't seen before: a robot that, even when the operators don't know what's going on, can still get through obstacles."

Robert Sim looks forward to getting out of the lab, too. Currently in the homestretch of his PhD in computer science, Sim writes software for the Mobile Robotics Lab, also part of the Centre for Intelligent Machines. In broad strokes, you might say that the ARL works on robotic brawn, while the MRL tackles the brains.

MRL's wheeled robots are mostly tested in the lab, far from the dangers of falling trees. "You beat up software in a different way," jokes Sim. "Our robots are more like R2D2; they're the ones that are stuck at the top of the stairs." He is, however, currently designing a vision-based localization system for the ARL's six-legged amphibious Aqua robot.

"My work is basically figuring out where the robot is in the world using a camera," he says. "So I have to deal with things like the motion of the water and changes in illumination. When the clouds come out, the whole picture really changes. Working outside the lab environment raises a lot of new challenges."

"Those are the kinds of things that really drive the people here," adds Smith. "Most of the robotics projects out there never see the light outside the lab, but our projects are different. They actually have real potential to be used outdoors. In the end, the robots we're building aren't made for linoleum floors, they're made for unstructured terrain where we don't know what's around the next corner. They're designed to overcome obstacles that occur in the real world, and that's what's fun about this work."

Watching ARL's robots overcome these obstacles, it's easy to mistake them for sentient creatures. (Godspeed, wee RHex, ever-plucky in the face of adversity and rocky cliffs.) Maybe it's subliminal residue lurking in the more biologically-inspired aspects of the movement. Maybe it's the result of watching too many sci-fi movies. Whatever it is, the ARL robots almost seem to be living, breathing things.

Except to the people who make them.

"No," says Smith, "it's easy for me to draw that distinction. After you take a robot apart a couple of times, the extent of any 'personality' is just that it needs a lot of attention."

"With over 300 bolts that need tightening," he laughs, "Scout is just high maintenance!"

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Last modified
2003-05-22