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A Sexy, Cool Robot Indeed

Sexy doesn't always entail frills and curves, especially when it comes to robots. In the case of the robotic device built by Dartmouth College engineers, their "cool robot" is a sexy, sleek "box on wheels." Weighing in at a svelte 150 pounds, the Dartmouth robot can certainly not be called fast—the robot's top speed is about 1.2 m/s, or about the clip of a brisk walk—but after being field tested at Summit Station, Greenland, the robot proves that it can hold its own in harsh environmental conditions and rugged terrain.

Setting up a research station in the Arctic is expensive, logistically difficult, and time-consuming—factors that are exacerbated if station operation requires constant refueling and maintenance. When a fellow colleague pointed out the potential that mobile research platforms could offer to scientific researchers who collect field data in the Polar Regions, Laura Ray and fellow robotics researcher Jim Lever jumped on the opportunity. Ray, an associate professor in the Thayer School of Engineering at Dartmouth College in New Hampshire, has substantial experience with applying control theory to modulate dynamic mechanical systems, while Lever's domain is mobility modeling. Building a mobile research platform, or robot, that can operate semi-autonomously in inclement, rugged terrain seemed like an ideal project given their abilities. The National Science Foundation evidently agreed, because the body agreed to back Ray and Lever through a Small Grant for Exploratory Research that began in the fall of 2003.

Using these monies, Ray's research team, notably including graduate student Alex Streeter, built the robot from the ground up to marry several key design features. First, the crew decided to have the robot operate off of a renewable energy source—an easy decision since having to fly in fuel to repower the robot would obviate the low-cost, autonomous nature of the thing. Hence, solar power seemed like an obvious energy choice. The team opted for a cuboid shape with solar panels all around to maximize solar light capture. As Ray explains, "Light reflections off of the snow really drive the robot design. Based on the configuration of the panels, the robot can operate continuously under most conditions in polar environments." This energy is harnessed to operate four motors, one for each wheel, to give the robot 4WD capability to traverse across uneven terrain, namely sastrugi, wave-shaped ridges of snow formed by the wind. Finally, the group designed the robot to be relatively small but large enough to carry scientific and technical equipment, such as a magnetometer to measure the earth's magnetic field and a global positioning system (GPS) unit that is used to help the robot navigate. In the end, the robot measures about 1 meter wide by 1 meter deep by not quite 1 meter tall. All this for a price tag between $15,000 and $17,000—including all the design iterations. Moreover, the project was entirely student-run; no PhDs or technicians were involved. The ingenuity came strictly from Streeter, who is working on the robot as part of his master's thesis; master's candidates and exchange students from Germany; and Dartmouth undergraduates Alex Price and Dan Denton.

Designed to drive over rolling sastrugi on the Antarctic plateau, the robot demonstrates its capability to drive over wind-rows of plowed snow. Although it looks precarious, the robot has a very low center of gravity and plenty of torque for negotiating such obstacles.

Streeter and Lever recently returned from Greenland, where they tested the robot design. After two weeks of frigid testing, the robot proved that it could navigate autonomously over long distances after being directed where to go by GPS, handle rugged terrain and soft snow like a natural, operate solely on solar power so long as the sun was out, and tow baggage weighing about three times its weight (~450 lbs). A pretty good start for the first real deployment of the robot! "The operational experience that we've gathered here will lead to a number of design improvements. Redesigns of both the hardware and software will result in a more robust system, with improved performance, which could be used as a platform for any number of

For more information about this research, check out the following link:
http://thayer.dartmouth.edu/other/crobots/index.html

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GREENLAND News From the Field...

VPR's Jason Buenning takes time out from end of season activities to play a few holes at Kangerlussuaq's golf course.

Kangerlussuaq The final flight week in Greenland went off without a hitch. Three 109th C-130s arrived in Kangerlussuaq on Monday and flew all scheduled flights to Summit and Raven on Tuesday. Weather in Kangerlussuaq was stellar – sunny, dry and in the low 60s. Logistics Manager Robin Abbott's sunflowers on the front porch of the KISS have started blooming, much to the delight of KISS denizens and local bees.

A number of Danish researchers were in town this week. Bent Hasholt from the U. Copenhagen's Institute of Geography uses digital cameras to measure and record landscape changes, ice cover and ice movement. It was Bent's data logger that VPR staff rescued from the shoreline of the Watson River when the river was at its height and about to swamp the logger. During his stay in Kangerlussuaq Bent measured where the river crested - 70 cm above where his data logger had been sitting. Read more about Bent's work at http://www.geogr.ku.dk/staff/bh/.

Also from the University of Copenhagen, NGRIP's Dorthe Dahl-Jensen transited through Kangerlussuaq en route to the Nordic Council's Greenland Meeting on Climate in Ilulissat. After the close of the meeting attendees returning to Copenhagen had a short layover in Kangerlussuaq. Dorthe took advantage of this opportunity to offer a quick visit to the KISS facility to several meeting attendees including Robert Corell, former NSF Program Officer and Arctic Climate Impact Assessment (ACIA) Steering Committee Chair.

More on NGRIP at: http://www.glaciology.gfy.ku.dk/ngrip/index_eng.htm
More on the meeting at: http://www.norden.org/webb/news/news.asp?id=5348&lang=6 and http://www.theregister.co.uk/2005/08/23/greenland_conference/.
More on the ACIA at: http://www.acia.uaf.edu/

The VPR presence in Kangerlussuaq was strong this week as contract staff returning from Raven and Summit and Denver-based staff in town for inventory work joined the Kanger "regulars". Everyone was very helpful setting up and drying out tents and weatherports and otherwise assisting the Kanger staff. Staffers also spent some time relaxing, joining in caribou hunts and golfing at the local sand-flat course. On Wendesday night the Kanger crew threw a barbeque at the KISS to thank everyone for such a great season before seeing them off on Thursday morning's southbound flights. Those who remained worked hard the rest of the week cleaning up, doing inventory, and otherwise buttoning up the Kangerlussuaq operation for the winter.

Summit The last flight week marked the official ending to Summit's summer season and the beginning of the first phase of the winter. On the 16th of August the last 109th flight of the season picked up 3 pallets and 9 summer crew members. Remaining on Station to hold down the fort until the November crew switch out are manager Kathy Young, mechanic Larry Levin, and science technicians Kim Wolfe and Steve Munsell.

The 16th also brought a change in the weather with winds up to 25 knots and blowing snow by Friday and Saturday. Sunday was a beautiful day, however, with light overcast, ice crystals filling the sky, and a huge halo around the sun.

The Summit Phase I winter crew: Larry Levin, Kim Wolfe, Steve Munsell and Kathy Young.

Larry and Kathy spent the rest of the week putting cargo on the winter berm and cleaning up after a very busy construction season. Kim and Steve were busy in the science realm, troubleshooting instruments that waited just until the departure of the summer technicians to act up. Thanks to their stellar teamwork instruments were back online by the end of the week. The crew also spent time this week establishing their roles for the winter, setting up schedules and discussing procedures for cooking, cleaning, medical drills, equipment training, generator training, fire call outs, medical call outs, camp boundaries, out of camp travel, and emergency caches locations. Continuing in the safety vein, Larry led a fire safety training class that focused on appropriate use of the various types of extinguishers at Summit.

On Friday night the crew celebrated with a nice dinner and toasted to a healthy and safe winter over. Kathy reports: "We are all anxious to get settled in and enjoy the changing light and weather that makes Summit such a special place this time of the year."

Raven After completing much of the cargo pull-out the week prior, Camp Raven took only 2 flights to pull the remaining cargo and crew and close camp for the season. Left behind for next spring's put-in are enough skiway markers to aid with landings as well as the emergency shelter and supplies on a snow berm for easy put-in access next season.

ALASKA News From the Field...

Fairbanks VPR's Tracy Dahl and Brian Buckley are back in Fairbanks putting away gear after completing a successful power system maintenance/upgrade visit to Ivotuk. SRI colleague Roy Stehle completed his comms work and pulled out earlier in the week.

A sunny day at Ivotuk. Photo by Roy Stehle

Along the Arctic Coast Chien-Lu Ping and crew continued Barrow based flying in support of their coastline erosion studies through August 15th. On the 16th, a BASC charter brought the team to Helmericks, at the mouth of the Colville, to continue helicopter-supported fieldwork in that area until the 20th. Find out more at:
http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0436179

Carin Ashjian and team used the research vessel Annika Marie to take zooplankton, temperature, and salinity measurements of possible bowhead whale feeding areas from Prudhoe Bay to Barrow. For more on this collaborative study of environment-whale-human interactions go to:
http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0436131

In Kaktovik, Matt Nolan's team awaited favorable weather conditions to get the group into their McCall Glacier camp by 19 August to begin fall work. More about the science at:
http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0229705

Toolik Nolan colleague Kenji Yoshikawa completed science flying for his part of this collaborative study of freshwater storage in the Arctic.

Fritz Nelson and his team finished their Toolik-based visits to CALM network sites around the Sagwon and Happy Valley areas. Read more at: http://www.vecopolar.com/arlss_reports/arlss_projectsdetail.asp?cbPropNum=0352958

The construction crew arrived on August 17th and began working on the shower module addition the next day. By week's end, walls and roof trusses were up. Additionally, the water supply has been installed in Lab 3 and 4.

In the News...

Three Polish researchers were rescued in the Svalbard archipelago after their inflatable boat capsized, stranding them at the edge of a small bay on the island of Egdeoya. More at: http://seattletimes.nwsource.com/html/nationworld/2002444028_rescue18.html

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studies," stated Streeter in his blog of the robot field test.

Indeed, NASA has expressed interest in using the robot for a 3000-kilometer autonomous robot traverse from South Pole Station to the British-operated Halley Station. The robot would be required to take snow samples every 25 meters for bacterial analysis as a pilot test for ice cap measures that are planned to someday take place on Mars. With a penchant for extreme environments, the robot could also be used for desert research. "We are analyzing the energy budget of the robot to see if it is scalable to other environments. The desert would be ideal because there is an ample solar resource," says Ray. Who knows, this may be the start of an autonomous, mobile research revolution! **—Kara Nyberg, PhD**

Many thanks to Laura Ray for providing information and to Alex Streeter for providing photos.

The robot's solar panel box measures approximately 47x47x32 inches. With the top panel in place, the five solar panels can gather upwards of 400 W of power, far in excess of the 250 W needed for the robot to drive.