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Cool Robots for Polar Instrument Networks

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Abstract

Why develop polar robots? As with space missions, logistics costs predominate polar-science budgets owing to the need to maintain safe human operations in these harsh environments. Reducing this logistics burden would greatly expand research opportunities in the Polar Regions.

Through funding from the U.S. National Science Foundation, we have designed and tested a simple four-wheel-drive, solar-powered *Cool Robot* to conduct autonomous summertime science campaigns in Antarctica and Greenland. The 60-kg robot measures 1.2 x 1.2 x 1 m and can carry $\sim$ 20 kg science payload or tow $\sim$ 40 kg on a sled. A low-profile chassis supports a five-sided, lightweight box of solar cells. Reflected sunlight from polar snowfields contributes 20 – 40 % of the power input, and the side panels capture this power while avoiding the complexity of sun-tracking. Under clear skies, 15 W of payload power are available while the robot drives and over 200 W when it is stationary. The robot requires no fuel caches, no food or lodging, and no health or safety infrastructure. It is zero emissions, so it can conduct clean snow and air measurements without being trailed by its own pollutants. It will fit inside the cargo bay of a Twin Otter aircraft for easy transport. The robot should cost under $20,000 if produced in lots of 10. Tests conducted in Greenland in 2005 indicate that the robot should exceed its design goal of carrying a 15-kg payload across 500 km of the Antarctic plateau in less than 2 weeks.

A fleet of *Cool Robots* could support a host of polar science projects in a season, while roaming or stationary: traverses to collect glaciological data, biological samples and ground truth information under satellite swaths; site inspections for meteorite fields, crevasse detection in advance of manned traverses, airfield geophysical surveys, and

routine snow-road surveys. Arrays of mobile robots would allow instruments to be dynamically positioned based on preliminary data or to respond to specific events. Array-based campaigns could include study of the polar atmospheric, magnetosphere and sub-glacial geology. The robots could also serve as high-bandwidth data relays for stationary instrumentation.

We have proposed a five-year, $1.9M project to upgrade the *Cool Robot* and demonstrate its capabilities to deploy polar instrument networks. We will refine the design for reliable, long-duration deployment in Antarctica and Greenland, construct 5 prototypes, quantify their capabilities through field tests, and commission the network by conducting two polar-science demonstration projects. Upgraded goals include 1,500 – 2,000-km summertime traverses of Antarctica and Greenland, safe navigation through 0.5-m amplitude sastrugi fields, survival in blizzards, extension to over-winter data-gathering and network adaptation to research events of opportunity. We are seeking to establish a users group of scientists interested in using *Cool Robots* on collaborative research projects. We have the design tools and polar experience needed to scale or optimize the robot for a variety of polar-science campaigns, based on the requirements proposed by these users.