Robotic Search for Antarctic Meteorites

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Objectives

*Develop meteorobot technology and demonstrate robotic search with planetary analogs of environment, electromechanical excursion, autonomous navigation, communication, and science in Antarctica*

Use human-assisting robots to find meteorites otherwise overlooked by humans and in areas challenging to human search
Sensors for Detection and Identification of Meteorites

Autonomous Meteorite Classification from Robot

Reliable Robot Assistant to ANSMET Field Team
Atacama Desert Trek - July 1997

- Nomad detected planted meteorites with magnetic/eddy current sensors
- Performed 50+ km of autonomous patterned searches
- Sensors discovered in-situ meteorites
Patriot Hills Experiments - January 1998

- Performed 15+ km² of searches for meteorites
- Made thousands of radar measurements at 5 locations
- Acquired 300 spectra and images of meteorites (10) and native rocks (80)
- Acquired 625 panoramas

Base Camp

80° 21' S - 81° 20' W
Technical Finds

Optical spectroscopy:
- Meteorites spectrally distinct from 90% of local rocks in the visible range
- Proximity to sample and artificial illumination critical

Radar modeling and search:
- Detected meteorites at shallow submergence (10 cm)
- Distinguished ice-snow-bedrock layers & crevasses

Panoramic imagery:
- Can track 10 cm object at 5 m
- Direct sunlight provides rich texture across blue ice to track ground features
Technical Finds

Solar energy collection:

- Average generated power 70 W/m²
- Diffuse and reflected light from ice account for 30% of solar energy

Communications (NASA Ames experiment):

- TDRSS is a viable option for Patriot Hills operations
- 4 successful 4.8 Kbs data transmission sessions using PortComm unit
Upcoming Antarctic Demonstration

- Robotic meteorite classification
- Autonomous ice traverse
Expedition Profile

- Field party from CMU, NASA Ames, UPitt, INACH
- 4 weeks / mid November - mid December 1998
- Collaboration with FACH/INACH
- At Patriot Hills: Robotic meteorite search and autonomous ice traverse
  - Potential scenario: circumnavigate Patriot Hills
- At Pecora Escarpment: Human meteorite search and sensor validation
  - Potential scenario: Transport with Twin Otter (~800 km), search main icefield
Robotic Meteorite Confirmation

• Multiple sensors for meteorite detection and confirmation
• Hierarchical utilization of sensors (coarse: vision, medium: EM, fine: spectroscopy)
• Precise sensor placement with manipulator mechanism

Target: 30 planted meteorites, 300 rock samples
Autonomous Ice Traverse

- Safeguarded autonomous navigation of icefield with laser and stereo
- Landmark based navigation from panoramic imagery
- Patterned search for maximum area coverage and optimal utilization of onboard power

Target: 20 km map distance, 40 km terrain distance
Summary of Objectives

- Polar robot operations
- Robotic meteorite discovery
- Robotic sensors and classifiers for detection and confirmation of Antarctic meteorites
- Validation of technologies of science autonomy, ice autonomous navigation, multi-scale planning and pose estimation, and ice mobility