Robotic Search for Antarctic Meteorites

Dimi Apostolopoulos

Carnegie Mellon University

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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

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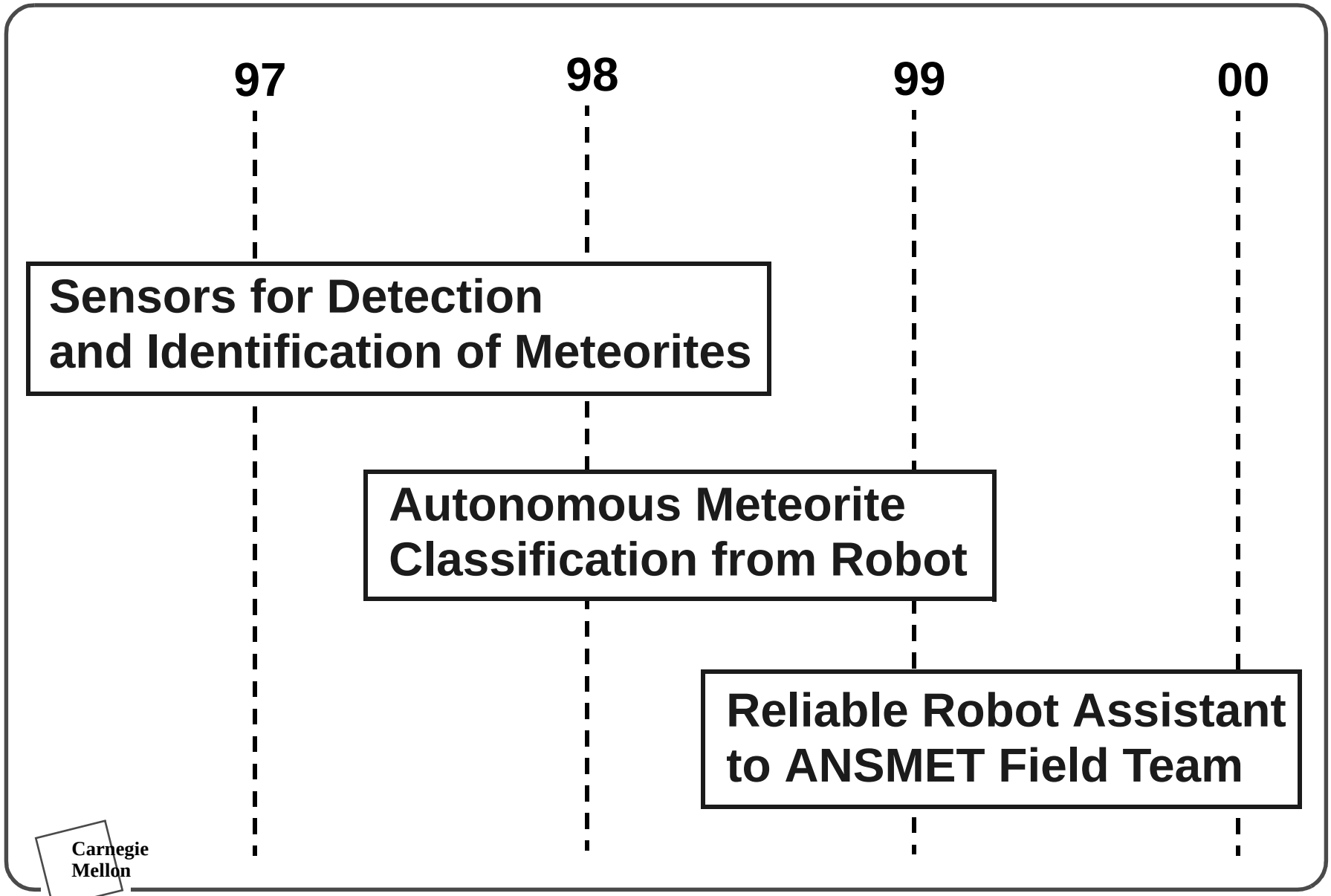
Roadmap



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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

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Patriot Hills Experiments - January 1998

- Performed 15+ km^2 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

solar

spectrometer

TDRSS comm

panospheric camera

GPS

radar

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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**

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Technical Finds

Solar energy collection:

- **Average generated power 70 W/m^2**
- **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**

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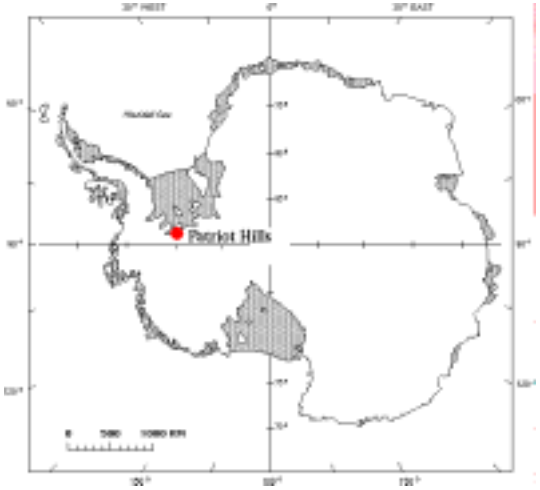
Upcoming Antarctic Demonstration



- **Robotic meteorite classification**
- **Autonomous ice traverse**

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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

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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

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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

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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**

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