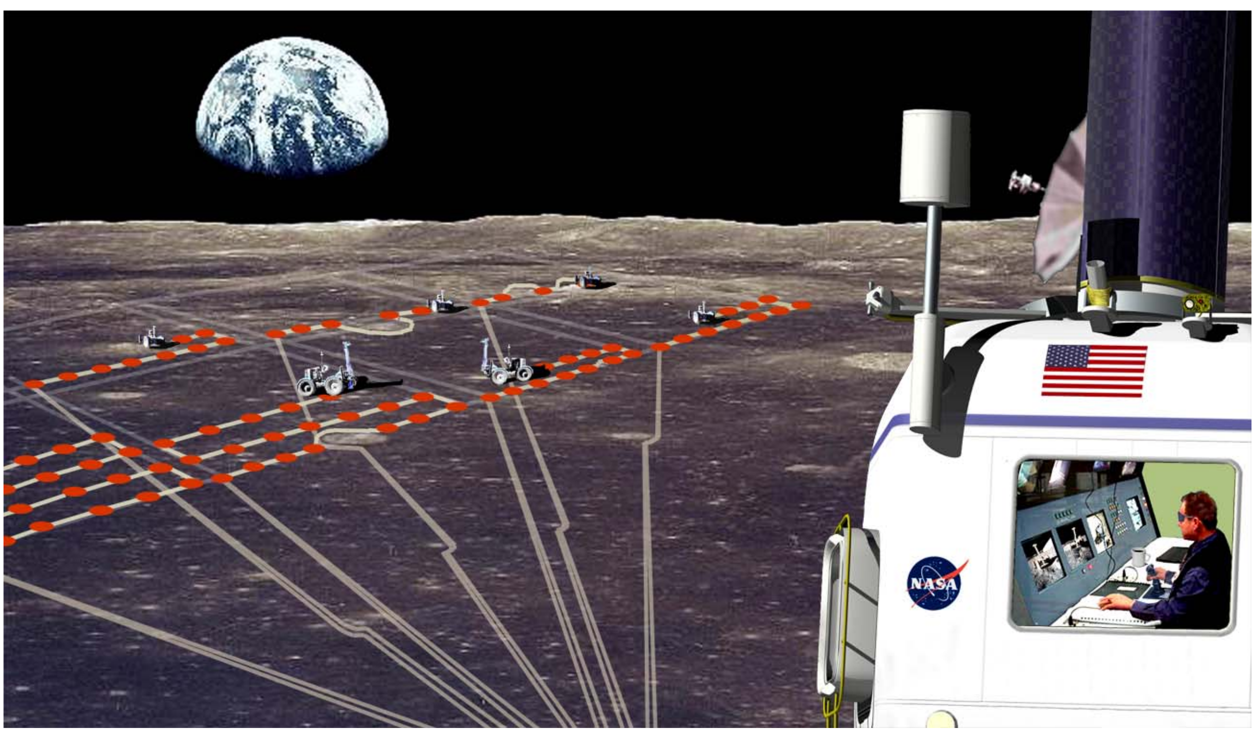
Wide Area Prospecting Using Supervised Autonomous Robots

Supported by the Exploration Systems Mission Directorate of the National Aeronautics and Space Administration

In January 2004, NASA established a long-term program to extend human presence across the solar system, a primary goal of which will be to establish a human presence on the moon no later than 2020, as a precursor to human exploration of Mars. A central concept of this vision is that future space exploration activities must rely on human and robotic capabilities combined in order to achieve a long-term and well-orchestrated campaign of space exploration (H&RT Formulation Plan). In order to meet these technological challenges, systems which support safe human supervision of fleets of task-oriented robots will be a necessity for future space exploration endeavors.

This work is in support of NASA’s Exploration Systems Mission Directorate's Research & Technology Development program. Our primary goal is to develop a general and widely applicable architecture for human supervision of a fleet of autonomous robots in support of sustained, affordable, and safe space exploration.

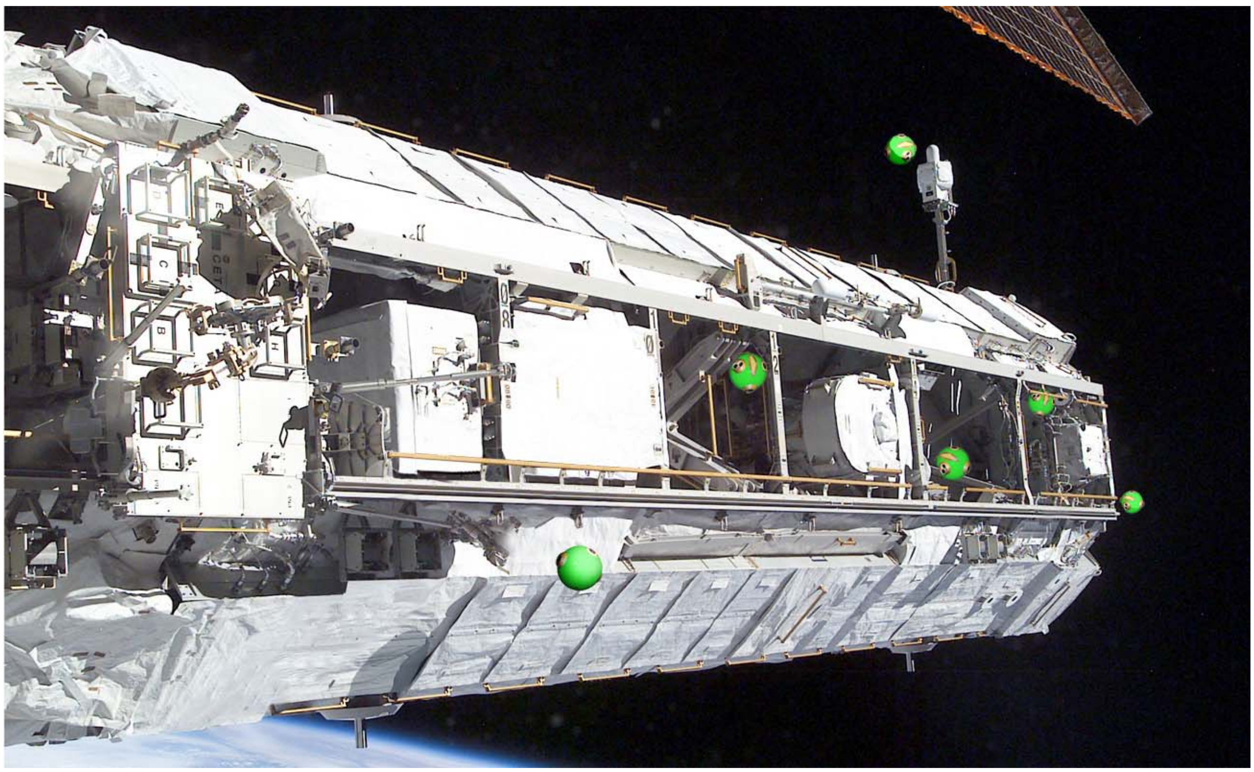
To realistically achieve this goal, it is necessary to prove the supervision architecture in a complete working system (including all sub-systems) and use this to measure the performance improvement of one remote operator supervising a fleet of robots compared with one operator alone in a vehicle. In Phase I we will test and demonstrate the architecture’s feasibility and usefulness by tasking a fleet of adapted robots vehicles with wide-area prospecting for mineral resources for *in situ* utilization. This initial instantiation of the telesupervised autonomous robotic technologies described in this project is referred to as PROSPECT: Planetary Robots Organized for Safety and Prospecting Efficiency via Cooperative Telesupervision.



Artist’s conception of telesupervised wide-area robotic prospecting on the Moon.

We note, however, that the paradigm of a human-supervised fleet of autonomous robots is not limited to planetary prospecting; it is also directly applicable to a variety of tasks in other realms such as space assembly, inspection, and maintenance; and mining and construction.

To take inspection as an example: the comprehensive and periodic inspection of large space structures requires an inspector to visit each critical site of the structure. One astronaut in a maneuvering unit can only inspect a limited number of sites in one shift; to accomplish the inspection goal, he spends most of the time unproductively flying from one site to the next. The provision of a fleet of autonomous inspection robots would make realizable the parallelization of the task and safety improvements and reduction in fatigue for the astronaut. The same architectures for navigation, hazard and assistance detection, and hand-off to a teleoperator working through a high-fidelity telepresence system are applicable.



Concept of ISS truss inspection incorporating supervised autonomous AERCams.

Our approach to delivering the capabilities required for human-robot collaboration and communication is based on the development of a robot supervision architecture which serves as the overarching framework for all subsystems

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