Using the ISS to Prepare for Exploration (01)
Exploration Technology Demonstrations Using ISS (2)

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# THE HUMAN EXPLORATION TELEROBOTICS PROJECT

**Abstract**

The purpose of the Human Exploration Telerobotics project is to demonstrate how advanced, remotely operated robots can increase the performance, reduce the costs, and improve the likelihood of success of future human exploration missions. To do this, we are using the International Space Station (ISS) to test new telerobotic systems, which can be remotely operated by ground controllers on Earth and by astronauts in space.

Future human missions to the Moon, Mars, and other destinations offer many new opportunities for exploration. However, crew time will always be limited and some work will not be feasible for astronauts to do manually. Robots can complement human explorers, performing work under remote control from a crew vehicle, or even from Earth. A central challenge, therefore, is to understand how human and robot activities can be coordinated to maximize crew safety, mission success, and scientific return.

The functional space of telerobots is extremely large, especially when considering all the systems that might be deployed on planetary surfaces, to small bodies (e.g., near-Earth asteroids), in-space, and on flight vehicles. Thus, in order to test different aspects of telerobots for human exploration, we are working with a variety of robots: the Robonaut 2 dexterous humanoid, an upgraded SPHERES free-flyer, the K10 planetary rover, and the ATHLETE robot. We are using these robots to test five prototype telerobotic systems: IVA Dexterous Manipulator, IVA Free-Flyer Mobile Sensor, EVA Dexterous Manipulator (simulated), EVA Free-Flyer Mobile Sensor (simulated), and Crew Controlled Surface Telerobot.

To date, NASA mission operations have focused on different concepts of operation for human and deep space robotic programs. Future deep-space human missions, however, will need to combine aspects from both concepts of operations. Moreover, missions that combine human and robotic activity will need to take into consideration operational constraints due to location, communication link characteristics, and timelines (strategic, tactical, execution), all of which may vary. Thus, our ISS tests include remote operation of robots by both ground control and crew, a variety of control modes, and trading/sharing of control.

Our goal is to help mitigate risk by testing and proving methodologies that can be used in future human and robotic missions. We anticipate that the results of our ISS tests will inform the on-going

development of exploration architectures and design reference missions, will help evolve new approaches to human controlled robotics, and will enable new ways to explore space using humans and robots.