National Aeronautics and Space Administration

NASA**facts**

Space Technology
Game Changing Development
Astrobee: ISS Robotic Free Flyer

Overview

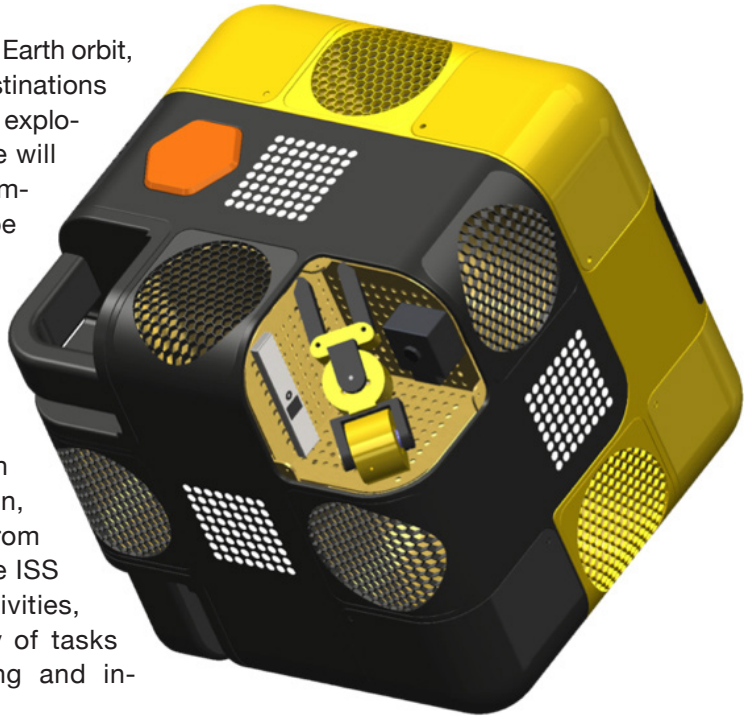
Astrobee will be a free-flying robot that can be remotely operated by astronauts in space or by mission controllers on the ground. NASA is developing Astrobee to perform a variety of intravehicular activities (IVA), such as operations inside the International Space Station. These IVA tasks include interior environmental surveys (e.g., sound level measurement), inventory and mobile camera work. Astrobee will also serve as a platform for robotics research in microgravity. Here we describe the Astrobee project objectives, concept of operations, development approach, key challenges, and initial design.

Motivation

Future human space missions in Earth orbit, to the Moon, and to distant destinations offer many new opportunities for exploration. However, astronaut time will always be in short supply, consumables (e.g., oxygen) will always be limited, and some work will not be feasible or productive for astronauts to do manually. Remotely operated robots, however, can complement astronauts by performing this work under remote supervision by humans from a space station, spacecraft, habitat, or even from Earth. Today, astronauts on the ISS not only conduct science activities, but they also perform a variety of tasks required for ISS housekeeping and in-flight system maintenance.

The remote monitoring and operation of many ISS systems by ground control has become an accepted practice for certain ISS tasks during the past decade. In terms of telerobotics, however, these tasks are limited to coarse positioning of external payloads/structures using manipulator arms, such as the Space Station Remote Manipulator System.

However, other types of robots, particularly free flyers, can perform a greater variety of tasks. These tasks include routine, repetitive or simple but long-duration work, such as conducting environment surveys, taking sensor readings or monitoring crew activities.



Artist's concept of the Astrobee robotic free flyer.

Development

NASA has been developing the Astrobee free-flying robot Since 2014 as part of the NASA Human Exploration Telerobotics 2 (HET2) project. This new robot will build upon technology and lessons learned from the Smart Synchronized Position Hold, Engage, Reorient, Experimental Satellite (Smart SPHERES) robot. Astrobee will be designed to address a variety of scenarios including mobile sensor (e.g., imagers or sound level meters), automated logistics (e.g., mobile inventory), and free-flying robotic test bed.

Astrobee will develop and test robot technologies required for autonomous operations, mobility, and remote operation by ground controllers, and human-robot interaction with crew. These technologies include propulsion, robot user interface (proximal and remote), supervisory control, payload interface, and navigation.

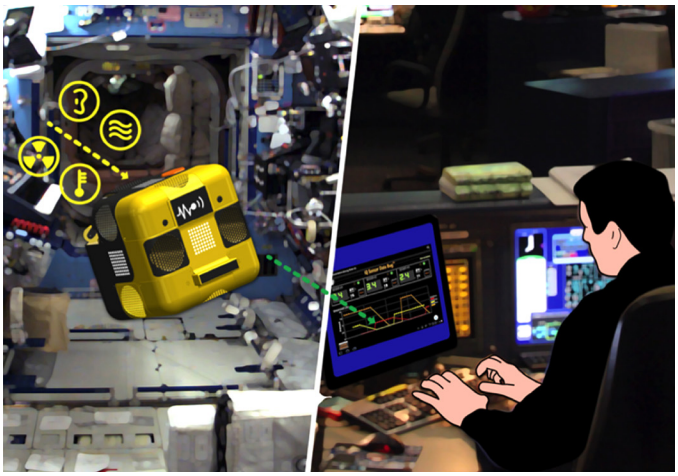
The Astrobee system objectives are to:

- Provide a microgravity robotic research platform for the ISS.
- Perform mobile camera tasks in the ISS U.S. On-orbit Segment (USOS).
- Perform mobile sensor tasks for environment monitoring and logistics in the ISS USOS.

At the highest level, the system includes the Astrobee itself, a dock/resupply station for replenishing power, and any necessary hardware and software for communication, control and data transfer.

The Astrobee will be self-contained and autonomous with the capability of being manually controlled as well. Ideally it will be capable of fully autonomous localization and navigation inside the USOS of the ISS. The Astrobee will have video cameras on board that will allow it to serve as a remotely operated mobile camera platform, and may be used for localization and navigation.

The Astrobee will also have expansion ports where additional sensors and/or hardware can be attached for demonstration, testing and use aboard the station. Additional



Artist's concept of the Astrobee free-flying robot performing a mobile sensor task.

sensors that may be attached to or integrated with the Astrobee include a RFID reader and the necessary software to communicate with the inventory management system, a sound level meter, and a HD camera.

The Astrobee will communicate principally via the station LAN. The propulsion is likely to be electric-motor-driven fans. Localization may include vision-based navigation with and without fiducials and wi-fi localization. The Astrobee will also include a perching arm to grab ISS handrails; this will allow the Astrobee to hold position without using its propulsion system.

The NASA Game Changing Development (GCD) Program (Space Technology Mission Directorate) and ISS SPHERES Facility (Human Exploration and Operations Mission Direcorate) provided funding for this work.

The GCD Program investigates ideas and approaches that could solve significant technological problems and revolutionize future space endeavors. GCD projects develop technologies through component and subsystem testing on Earth to prepare them for future use in space. GCD is part of NASA's Space Technology Mission Directorate.

For more information about GCD, please visit http://gameon.nasa.gov/

National Aeronautics and Space Administration

Ames Research Center
Moffett Field, CA 94035

www.nasa.gov