



Astrobee: A Stepping Stone to Caretaking Intra-Vehicular Robots

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ABSTRACT

The Astrobee Project has developed next-generation free-flying robots to operate inside the ISS. The first two Astrobee Free Flyers reached the ISS in April 2019 and are currently in their commissioning phase, validating performance on-orbit before beginning their primary mission.

Astrobee's primary objective is to provide a highly flexible and capable free-flying robotic research platform to enable future guest scientist investigations, replacing the aging Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES). However, Astrobee is also designed to demonstrate the feasibility of intra-vehicular robots (IVR) for performing key caretaking functions within future exploration vehicles as part of NASA's Moon-to-Mars exploration strategy. IVR capabilities will be especially vital during uncrewed mission phases. For example, current plans call for the lunar Gateway to be uncrewed >85% of the time.

Astrobee's baseline implementation supports *free-flying camera* and *sensor survey* use cases. Future software updates and peripheral hardware mounted in the free flyer payload bays could enable *cargo transfer* and *fault isolation* use cases, among others. Astrobee can demonstrate these capabilities on the ISS, and can also serve as a reference design for future mission-critical IVR free-flyers. (Astrobee itself was developed as an ISS payload research-grade system and thus not built to mission-critical quality standards.)

We emphasize that the greatest benefit of future IVR systems will be for uncrewed mission phases, providing vital services that we are accustomed to crew performing on the ISS. It is a much higher bar to provide genuinely useful IVR services onboard the ISS itself, given that it typically means rethinking a mature existing procedure developed for crew, using interfaces designed for humans, to be compatible with much more limited robotic capabilities. However, we have identified some early candidate activities for automation, including audio and video surveys (recurring tasks that today require crew to laboriously carry a microphone or camcorder to sample at various points throughout the ISS). As Astrobee completes its commissioning, we are beginning more detailed discussions with ISS operational organizations in order to develop a business case for investing in automating these services and saving crew time.

This presentation will focus on 1) initial reporting on Astrobee commissioning activities completed prior to the R&D conference, 2) Astrobee's role in demonstrating IVR capabilities for future exploration missions, 3) possibilities for using Astrobee to automate ISS services.