Astrobee: Improving Capabilities for Free Flying Robotic Technology Demonstrations

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ABSTRACT

The Astrobee Project has completed three years operating inside the ISS. Three Astrobee Free Flyers reached the ISS in April 2019 and are currently hosting a variety of users. During this time, Astrobee has advanced the state of the art in free-flying robots on ISS, operated over 100 sessions, logged over 750 hours of free-flyer operation, and made several capability improvements.

Astrobee's primary objective is to provide a highly flexible and capable free-flying robotic research platform to enable future guest scientist investigations. However, Astrobee is also demonstrating the feasibility of intra-vehicular robots (IVR) for performing key caretaking functions within 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. Astrobee guest scientists can deploy software updates and hardware payloads to extend its capabilities. Astrobee is continuously improving its navigation robustness, general flight software maturity, and ISS interior maps, both through the baseline Astrobee operations and with the help of the ISAAC project. Astrobee began with mapping, localization, and operations in the Japanese
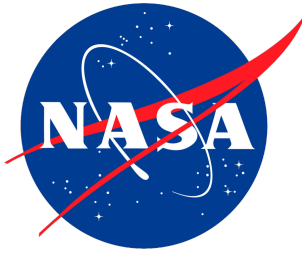
Engineering Module (JEM), and has expanded to mapping in Node 2 and the US Lab. Astrobee has improved localization and operational robustness through improved mapping processes, algorithm updates that reduce the occurrences of lost localization as well as developed recovery techniques to return to a good localization fix when loss of localization does occur.

Future guest science experiments currently in development could demonstrate *cargo transfer*, *fault isolation*, *free flyer and stationary robot collaboration*, *microgravity fluid transfer*, and *new docking mechanisms*, among others.

This presentation will focus on 1) Astrobee technical capabilities 2) What Astrobee can provide to a guest science experiment 3) Astrobee's recent improvements 4) Possibilities for using Astrobee for future investigations.