Future Free Flyer Science on the ISS

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The Astrobee Research Facility will maintain three identical free-flying Astrobee robots on the ISS. After the Astrobees are launched and commissioned in 2018, they will replace the SPHERES robots that have been operating on the ISS since 2006. Astrobee can fly autonomously throughout most of the US section of the ISS interior, but cannot operate outside the ISS. Astrobee is propelled by a pair of battery-operated fans, and can autonomously return to a docking station to recharge, so it can perform most activities without requiring any astronaut support. It carries a suite of six cameras, a two degree-of-freedom (DOF) arm with a gripper that can grasp ISS handrails and other objects, and three payload bays that provide power and data for guest science hardware. It can autonomously execute hours-long plans (for example, sensor surveys) or be teleoperated live from the ground or by astronauts.

Motion control:

Each Astrobee has 6-DOF holonomic motion capability (instantaneous thrust in any direction and torque about any axis) provided by 12 variable-thrust nozzles. This effectively allows each robot to simulate any space vehicle thruster con-figuration. Astrobee's baseline flight software will be open sourced and available to you as a guest scientist

Advanced propulsion / mobility hardware:

You can supplement Astrobee's built-in propulsion system with your own experimental mobility hardware (magnetic propulsion, hopping, you name it).

Robotic manipulation:

Each Astrobee carries a 2-DOF arm with a 1-DOF passively underactuat tendon-driven gripper, capable of grasping ISS handrails and other objec guest scientist, you can use the arm as-is, replace the standard gripper with own advanced gripper design, or replace the whole arm—all the hardware is designed for easy swapping by astronauts.

Multi-robot teams and formation flight:

The three Astrobee robots are capable of operating together and communicating with each other via the ISS WiFi network in order to support multi-robot experiments. Each Astrobee will be marked with visual fiducials that can be used by other Astrobees to track relative position.

Satellite inspection and rendezvous:

bee carries a suite of six cameras (including LIDAR sensors and a 21 MP camera), and can fly arbitrary holonomic trajectories around another strobee or a passive object. It can grasp an object with its arm to simulate rendezvous and maneuvering in a mated configuration.

The Astrobee robots are controlled by crew or by an Astrobee Operator (Astrobee Ops) on the ground using the Astrobee Control Station operator interface. An Astrobee Operator can be a flight controller at the JSC Mission Control Center (MCC), a payload controller at the MSFC Payload Operations Integration Center (POIC), an Astrobee engineer at the ARC Multi-Mission Operations Center (MMOC), or an Astrobee guest scientist at their approved institution.

The varying research opportunities and the ground support facilities available to support Guest Scientists will be covered in this presentation.