Autonomous Robotic Capture of a Free-Floating Payload in Near-Zero Gravity

Problem Statement

Current ground simulations of on-orbit autonomous robotic capture do not adequately model the small-scale 3D contact dynamics between a robot and a satellite. Some 2D and large-scale/low-bandwidth 3D simulations have been performed. NASA's parabolic aircraft provide a unique opportunity to collect data in a zero-g environment in order to advance the fidelity of ground simulations.

Technology Development Team

Satellite Servicing Capability Office – Code 408

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West Virginia University: Sensing algorithms

Yaskawa America, Inc: Robot manufacturer

Proposed Flight Experiment

Experiment Readiness:

- September 2012

Test Vehicles:

- Parabolic aircraft

Test Environment:

- Previous parabolic aircraft flight in July 2011

Test Apparatus Description:

- The robot will be fixed to the cage, which will be fixed to the aircraft. During each zero-g period, the mock satellite will be released so that it is free-floating within the cage. The robot will then try to track and grapple the mock satellite using its onboard sensing. A metrology system will independently measure the motion of the arm and mock satellite.

Technology Maturation

- July 2011 – Machine vision tracking of free-floating target
- Sept 2012 – Stable robot contact with free-floating target
- Sept 2012 – Preliminary autonomous capture of free-floating target
- 2013 – Robust autonomous capture
- 2013 – Validated ground simulation platform

Objective of Proposed Experiment

- Stable contact of robotic arm with free-floating satellite mock-up
- Relative motion, contact forces, robot position, and aircraft accelerometer data will be recorded
- Data will be used to increase the fidelity of ground testing simulations

Data collected will advance ground simulation fidelity and help NASA address the following RTA Technical Areas: 4.1) Sensing and perception 4.3) Manipulation 4.6) Autonomous rendezvous and docking