ISS R&D 2016 Conference Abstract

SPHERES: FROM GROUND DEVELOPMENT TO ISS OPERATIONS

By: A. Katterhagen[1]

[1]The Bionetics Corporation / Wyle Labs NASA Ames Research Center Moffett Field, CA

ABSTRACT

SPHERES (Synchronized Position Hold Engage and Reorient Experimental Satellites) is an internal International Space Station (ISS) Facility that supports multiple investigations for the development of multi-spacecraft and robotic control algorithms. The SPHERES National Lab Facility aboard ISS is managed and operated by NASA Ames Research Center (ARC) at Moffett Field California. The SPHERES Facility on ISS consists of three self-contained eight-inch diameter free-floating satellites which perform the various flight algorithms and serve as a platform to support the integration of experimental hardware. SPHERES has served to mature the adaptability of control algorithms of future formation flight missions in micro-gravity (6 DOF / long duration m-g), demonstrate key close-proximity formation flight and rendezvous and docking maneuvers, understand fault diagnosis and recovery, improve the field of human telerobotic operation and control, and lessons learned on ISS have significant impact on ground robotics, mapping, localization, and sensing in 3D - among several other areas of study.

As a result of the unique capabilities of the SPHERES satellites, research over the years evolved beyond just the satellites to support a series of investigations that involved the integration of peripheral hardware to the satellites. These investigations have explored such fields of study as ground/crew control & communication (Interact), vision based navigation (VERTIGO), EMFF for the first time in full 6 DOF micro-gravity (RINGS), first-ever simultaneous control of ground robot team members and crew operators in space (Smartphone), and one of kind extended fluid dynamic studies (Slosh). In latest research, SPHERES is testing newly arrived hardware that tests the maturing of adaptive GNC technology (guidance, navigation, and control) in support of on-orbit, robotic satellite assembly in a risk-tolerant, dynamically-authentic environment with new docking capabilities. All of the hardware supporting the above research is now part of the SPHERES Facility and some of it available to researchers today. With over 80 test sessions, for over a decade the SPHERES Facility has taken zero-gravity research to new levels.

To help make science a reality on the ISS, the SPHERES ARC team supports a Guest Scientist Program (GSP). This program allows anyone with new science the possibility to interface with the SPHERES Facility, team, and available hardware. This presentation will highlight ground support, the ISS Facility, and other resources available to guest researchers through the SPHERES GSP. In addition to understanding how a researcher can interface with the SPHERES Facility on ISS, this

presentation can serve also as a general guide to assist researchers in getting science to the Space Station.

Investigations on the ISS evolve through four main phases: Strategic, Tactical, Operations, and Post Operations. The Strategic Phase encompasses early planning beginning with initial contact by the Principle Investigator (PI) and the SPHERES program who may work with the PI to assess what assistance the PI may need. Once the basic parameters are understood, the investigation moves to the Tactical Phase which involves more detailed planning, development, and testing. Depending on the nature of the investigation, the tactical phase may be split into the Lab Tactical Phase or the ISS Tactical Phase due to the difference in requirements for the two destinations. The Operations Phase is when the actual science is performed; this can be either in the lab, or on the ISS. The Post Operations Phase encompasses data analysis and distribution, and generation of summary status and reports.

The SPHERES Operations and Engineering teams at ARC is composed of experts who can guide the Payload Developer (PD) and Principle Investigator (PI) in reaching critical milestones to make their science a reality using the SPHERES platform. From performing integrated safety and verification assessments, to assisting in developing crew procedures and operations products, to organizing, planning, and executing all test sessions, to helping manage data products, the SPHERES team at ARC is available to support microgravity research with the SPHERES Guest Scientist Program.

ISS025E013444