

Maturation of GNC Algorithms with SPHERES Aboard the International Space Station

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The Synchronized Position Hold Engage Re-orient Experimental Satellites (SPHERES) program was designed by the Massachusetts Institute of Technology Space Systems Laboratory with two primary objectives: (1) to develop a facility for the advancement of control, estimation, and autonomy algorithms for distributed satellite systems and (2) to maximize its positive impact in the use of the International Space Station by following a prescribed set of facility design principles. Each SPHERES satellite is a generic satellite bus with propulsion, avionics, power, communications, and guidance sub-systems. The Guest Scientist Program provides investigators a general programming to test their algorithms. Since operations began in May 2006, SPHERES scientists have conducted substantial research on formation flight and docking algorithms. Further, new programs have appeared which use the modular and generic nature of SPHERES. These include electromagnetic formation flight, vision-based navigation, fluid slosh dynamics research, docking ports, and a robust outreach program for high-school students in the USA and ESA member nations. In 2010 the DoD and NASA agreed to name SPHERES an official facility of the ISS National Laboratory Office, to be run by NASA Ames Research Center. The naming of SPHERES as such a facility validates the design principles on which it was designed.