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SWARM RPO AND DOCKING SIMULATION ON A 3DOF AIR BEARING PLATFORM

Abstract

With the emergence of the space servicing sector, along with the return of manned missions beyond low earth orbit, there is a need for quick, efficient, and most of all, safe Rendezvous and Proximity Operations (RPO). More than that, the next big step forward is manufacturing in space, which will require large swarms of spacecraft cooperating in close proximity to each other, all subjected to the same laws of orbital mechanics. Methods for swarm RPO safety are being developed but have not yet been tested in space. The most promising type of swarm RPO safety utilizes real-time GNC algorithms coupled with a variety of sensor inputs giving the position, velocity, and pose of all satellites in the swarm, to constantly update the relative-motion orbits of all the elements in the swarm, while propagating these orbits forward in time to prevent conjunctions.

The University of Southern California's Space Engineering Research Center (SERC) developed an in-house manufactured 3 DOF Air Bearing Platform (ABP), which has the ability to simulate the frictionless environment of space in a single plane. Using a system of three floatbots with onboard location and proximity sensors, the team at the SERC were able to demonstrate the effectiveness of real-time GNC algorithms for swarm operations. In addition to having three physical floatbots, more virtual floatbots were added in using Virtual Vector Force Fields (VVFF) to simulate the presence of more swarm elements.

Testing on the ABP allowed verification in the form of hardware-in-the-loop testing of the real-time swarm rendezvous algorithms to maintain safe operations while orchestrating the trajectories of many spacecraft in close vicinity of one-another. The results of this testing will be presented in this paper.