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THE DEVELOPMENT OF DYNAMIC GUIDANCE AND NAVIGATION ALGORITHMS FOR AUTONOMOUS ON-ORBIT MULTI-SATELLITE AGGREGATION

Abstract

With the growing popularity of low-cost satellite missions merged with the ability to potentially rendezvous and "connect" on orbit, the potential to enable mission objectives typically reserved for very large monolithic satellites with many small low-cost satellites arises through the possibility of on-orbit satellite "aggregation". Ultimately, such satellite aggregation concepts, resulting in a new singular spacecraft comprised from many individual functioning satellites, must adhere to basic spacecraft design considerations like attitude control and thermal management upon aggregation/integration. When considering on-orbit operations, an autonomous methodology must be implemented to ensure seamless spacecraft functionality and control upon aggregation. The University of Southern California Information Sciences Institute (USC ISI) and Space Engineering Research Center (SERC) have fabricated multiple modular pseudo-satellite prototypes and developed an autonomous GNC reconfiguration algorithm to redefine a singular reaction control system from multiple contributing spacecraft. These prototypes, bounded by 3 degrees of freedom on a frictionless air-bearing table, perform individual maneuvers with 8 body mounted thrusters to employ rendezvous and proximity operations (RPO) for docking and aggregation. Upon aggregation, the integrated algorithm will demonstrate autonomous reconfiguration of the aggregate spacecraft's thrusters as the spacecraft performs additional maneuvers with its new orientation. The facility also will introduce a simulation environment which considers additional virtual satellites to show the increased scale of the algorithm's capability in optimizing the aggregate GNC subsystem for up to "N" number of satellites. This paper will present preliminary results of the first set of algorithmic experimentation in active GNC autonomous satellite reconfiguration.