Paper ID: 40525
student

ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (3) (5)

Author: Ms. Rebecca Foust
University of Illinois at Urbana-Champaign, United States

Ms. Michelle Zhao
California Institute of Technology, United States
Ms. Suzanne Oliver
California Institute of Technology, United States
Prof. Soon-Jo Chung
California Institute of Technology, United States
Dr. Fred Hadaegh
Jet Propulsion Laboratory - California Institute of Technology, United States

DISTRIBUTED CONTROL OF AN EVOLVING SATELLITE ASSEMBLY DURING IN-ORBIT CONSTRUCTION

Abstract

This paper presents a method for controlling sets of docked satellites during in-orbit construction of a large-scale satellite assembly from a swarm of heterogeneous satellites. Such a system can be used to enable missions from sparse aperture telescopes to elaborate space stations. Once two or more agents from the swarm are docked, the resulting assembly is an over-actuated system so position and attitude controllers must determine which of the available actuators to use. Typically, control allocation for over-actuated systems is done using a simple linear program, but for this scheme the mass properties and number of control points changes. As a result, the linear program solved changes with each new agent that docks with the assembly so the agents must know how to alter the linear program for additional agents and remove control points whose plumes would interact with those agents. In most systems, this linear program is solved by a central computer, but for this system the actuators belong to distinct agents so to increase reliability, each agent solves the same linear program and executes its portion of the resulting control command. This paper sets up the general linear program that each agent in the assembly must solve and then establishes the rules for altering that program when new agents dock. Initial simulations allow the agents to dock as they come into proximity along their respective trajectories to their target locations. This can lead to instability and uncontrollability if the agents dock in certain configurations, so the control allocation rules are extended to prevent uncontrollable or unstable docking scenarios. The logic used for this is based on the moment of inertia and the available actuation ability. Simulations in 6DOF perturbed satellite dynamics show the efficacy of this approach in preventing uncontrollable assemblies and bringing the assemblies together into the desired final configuration.