IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (2)

Author: Dr. Sanjeeviraja Thangavel
Singapore, Republic of, thangavel.sanjeeviraja@singaporetech.edu.sg

Prof. Gianmarco Radice
Singapore, Republic of, Gianmarco.Radice@glasgow.ac.uk

DESIGN CHALLENGES OF AUTONOMOUS FORMATION CONTROLLER FOR SMALL SATELLITE MISSIONS

Abstract

Establishing clear control boundaries between attitude dynamics control systems (ADCS) and autonomous formation flight controls (AFFC) is paramount for small satellite formation flight architecture. The ADCS obtains input data from the controller for guidance, navigation, and control. AFFC has direct control over an actuator and sensors for satellite missions. This paper examines the recent development of miniature AOCS components and control design strategies (linear and nonlinear) and algorithms (propellant optimization, environmental perturbations, trajectory optimization, satellite reconfiguration and planning, attitude determination, orbit correction/prediction, and relative dynamics) to achieve AFF. The results are summarized in the high-level architecture specifications of the individual sensors, actuators, and controllers. In addition, numerical simulation results for the controllers (LQR, SMC, and MPC) were analyzed to determine their robustness and optimality. The proposed adaptive control system model reduces computation time, fuel consumption, and collision avoidance between follow-on satellites. Hardware reliability and high-confidence functional testing are considered when selecting the model for AFF.