ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation, and Control (5)

Author: Mr. Sergio De Florio
University of Glasgow, Space Advanced Research Team, Germany, Sergio.deFlorio@dlr.de

Dr. Simone D"Amico
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, simone.damico@dlr.de

FLIGHT RESULTS FROM THE AUTONOMOUS NAVIGATION AND CONTROL OF FORMATION FLYING SPACECRAFT ON THE PRISMA MISSION

Abstract

PRISMA is a small-satellite formation flying mission created by the Swedish National Space Board (SNSB) with the Swedish Space Corporation (SSC) as prime contractor and additional contributions from the German Aerospace Center (DLR), the French Space Agency (CNES), and the Technical University of Denmark (DTU). This mission will serve as a test platform for autonomous formation flying and rendezvous of spacecraft. PRISMA comprises a fully maneuverable small-satellite (Mango) as well as a smaller sub-satellite (Tango) which are launched together in a clamped configuration and separated in orbit after completion of all checkout operations. The mission schedule foresees a launch in April 2010 of the two spacecraft with a targeted lifetime of at least eight months. Through PRISMA, novel approaches in the areas of formation flying guidance, GPS based relative navigation, impulsive relative orbit control and space mission operations will have an in-flight validation. DLR's key contributions comprise the on-board GPS-based absolute and relative navigation system, the Spaceborne Autonomous Formation Flying Experiment (SAFE), the Autonomous Orbit Keeping (AOK) experiment as well as the on-ground Precise Orbit Determination (POD) layer. The on-board navigation system includes two Phoenix-S GPS receivers and the real-time orbit estimation software with a required absolute (relative) position accuracy of 3 (0.2) m (3D, RMS). The on-ground POD is requested to provide absolute (relative) position accuracies better than 0.5 (0.05) m (3D, RMS). The primary objective of the DLR's contributions to PRISMA is the SAFE experiment which implements autonomous formation keeping and reconfiguration for typical separations below 1 km. The required relative position control accuracy is 30 m (3D, RMS). The secondary objective of the DLR's contributions to PRISMA is the AOK experiment which implements an autonomous absolute orbit keeping demonstration of a single spacecraft with a required control accuracy of the osculating ascending node of 10 m (1). In this paper in-flight results of the PRISMA on-board GPS based navigation system and the SAFE experiment are presented. The on-board navigation performance is estimated through a comparison with the on-ground POD results and is evaluated in terms of accuracy requirements fulfillment and robustness in critical situations (e.g., attitude and orbit control maneuvers, large GPS data gaps). The autonomous formation flying control performance is evaluated in terms of control accuracy requirements fulfillment and formation reconfiguration capabilities. An overview is also given of the innovative and flexible PRISMA operations concept and the DLR's PRISMA Experiment Control Center (ECC).