Space Transportation (6)
Space Transportation (1) (1)

Author: Mr. Thomas Vincent Peters
GMV Innovating Solutions, Spain

Mr. Jose Francisco Briz Valer
GMV Innovating Solutions, Spain
Dr. Pedro Arroz
GMV-Spain, Portugal
Mr. Ferdinando Cometto
Thales Alenia Space Italia, Italy
Mr. Marco Berga
Thales Alenia Space Italia, Italy
Mr. Jose Alvaro PEREZ GONZALEZ
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France
Mr. Aurélien Cuffolo
Thales Alenia Space France, France
Mr. Alexander Cropp
ESA, The Netherlands

HERACLES LUNAR ASCENT ELEMENT GNC SYSTEM DESIGN

Abstract

This paper describes the design and testing of the guidance, navigation and control (GNC) system for the Lunar Ascent Element (LAE) of the international mission HERACLES. The LAE carries samples from the lunar surface to Lunar Orbital Platform – Gateway (LOP-G) space station. LOP-G is located in a near-rectilinear halo orbit (NRHO), a member of the halo orbit family that passes close to the lunar surface. The GNC design focuses on the three main phases of the LAE mission: launch, orbit transfer and rendezvous. The GNC for all three phases has been incorporated into a single simulator. The attitude navigation is based on star trackers and IMU measurements. Absolute orbit determination is performed on-ground. Narrow and wide angle cameras are present for relative navigation. The ascent guidance is designed using the linear tangent equations, based upon the classical optimization theory for launch vehicle trajectories. In the current GNC design all (launch, orbital and rendezvous) manoeuvres are computed on-board. The fact that the orbit transfer targets an NRO complicates the problem of the manoeuvre computation, as a simple Lambert solver does not work in the setting of the three-body problem. Rendezvous takes place close to the aposelene of the NRO. The rendezvous is composed of an impulsive and a forced motion segment. In the aposelene region of the orbit the dynamics are slow and the motion between impulsive manoeuvres is nearly rectilinear. The GNC for all three phases has been tested in a Monte Carlo campaign. Test campaign results show that the current GNC design is feasible. Based on the outcomes of the test campaign, recommendations are made to improve the design and reduce the required V.