Paper ID: 60086
oral
student

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

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SYSTEM REQUIREMENTS ANALYSIS FOR JAXA'S CONTRIBUTION TO COMET INTERCEPTOR MISSION: AUTONOMOUS NAVIGATION, GUIDANCE AND ATTITUDE CONTROL FOR A HYPERBOLIC COMET FLY-BY

Abstract

Comet Interceptor, to be launched in 2028, is a recently-selected ESA/JAXA mission aimed to perform the first fly-by of a hyperbolic comet. As part of the mission's Phases A/B (feasibility analysis and preliminary design), this work analyzes system requirements for JAXA's contribution to the mission: one of the two small spacecraft piggybacked along with ESA's main spacecraft.

Analysis focuses on the autonomous navigation, guidance and control of the spacecraft's trajectory and attitude during its 500-km, 70-km/s fly-by. Monte Carlo simulations are implemented to assess flyby accuracies and the robustness of the comet tracking control law. System component requirements are derived from these Monte Carlo simulations, in support of JAXA's preliminary spacecraft design.

Recommendations are made in regards to: (a) component allocation and performance (orbital thrusters, gyroscopes, reaction wheels, and navigation cameras), (b) scheduling of orbital propulsive maneuvers, and (c) attitude control for tracking of a hyperbolic comet with largely uncertain characteristics (size, luminosity, speed).

Trajectory dynamics are modeled in a high-fidelity ephemeris model and include uncertainties in the ephemerides of the target comet. Other uncertainties and errors considered in the Monte Carlo simulations involve: (a) component performance (sensors and actuators), (b) image processing, and (c) modeling of comet characteristics.

This study therefore provides a comprehensive analysis of component performance and autonomous navigation, guidance, and control strategies in support of JAXA's contribution to the first-of-a-kind Comet Interceptor mission. Main driving parameters and limiting factors for the mission are identified, and the overall feasibility of the mission is assessed.