Paper ID: 76618
oral
student

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

Author: Mr. Luis Mendoza Zambrano
Embry-Riddle Aeronautical University, United States

Dr. Riccardo Bevilacqua
Embry-Riddle Aeronautical University, United States

ROBUSTNESS TO NOISE ANALYSIS OF SOLAR SAILING ADAPTIVE CONTROL WITH SOLAR FLUX ESTIMATION USING FINITE EXCITATION

Abstract

With the desire of increasing robustness and improving transient performance, preceding research proposes an integral concurrent learning approach to account for solar flux fluctuations using finite excitation. Here, a reflectivity control device was used to adjust the thrust magnitude of a solar sail. However, the stochastic solar flux variation was neglected as well as measurement noise in the orbital and attitude states of the solar sail to consider. Additionally, the optical solar pressure model that captures the acceleration due to solar radiation pressure based on the thermo-optical film properties was assumed to be an exact representation of the spacecraft's dynamics. In this context, an extensive robustness to noise analysis is required to assess and test modifications to the control policy for future real-life applications in which one would need to estimate the solar flux to track a desire reference trajectory. This includes the implementation of robust adaptive control modifications such as the well-known sigma and e-modifications. Moreover, the extended Kalman filter is proposed as a state estimator methodology to account for measurement noise in the spacecraft state vector and attitude angles as expressed in the Local-Vertical Local-Horizontal reference frame. In the present study, an Earth-Mars interplanetary orbit in considered.

As a means to account for a realistic evaluation through a high-fidelity simulation, radiometric tracking techniques for deep-space navigation are assumed to properly model in simulation measurement noise. This also includes measurement error due to onboard optical sensors for attitude orientation. Initial results solely considering the stochastic solar flux fluctuation and the periodic variation due to the 11-year solar cycle indicate that accurate online estimation of this parameter is obtained within a relative mean error of just 0.5%. In this sense, the proposed formulation suggests a reliable method to minimize the deviation of a solar sail trajectory from its reference for which a constant value of the solar flux is often assumed during the preliminary phase of the mission.