Paper ID: 51840
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (2) (8)

Author: Mr. Constantin Traub
Institute of Space Systems, University of Stuttgart, Germany, ctraub@irs.uni-stuttgart.de

Dr. Georg Herdrich
Institute of Space Systems, University of Stuttgart, Germany, herdrich@irs.uni-stuttgart.de
Prof. Stefanos Fasoulas
Institute of Space Systems, University of Stuttgart, Germany, fasoulas@irs.uni-stuttgart.de

INFLUENCE OF ENERGY ACCOMMODATION ON A ROBUST SPACECRAFT RENDEZVOUS MANEUVER USING DIFFERENTIAL AERODYNAMIC FORCES

Abstract

Differential aerodynamic forces are a promising propellant-less option to control satellite formation flight. To this day, satellite lift is most frequently neglected and, as a consequence, the methodology of differential lift only poorly studied. This is because the adsorption of atomic oxygen on the satellite's surfaces in Very Low Earth Orbit (VLEO) induces diffuse reflection and high energy accommodation, both of which explains the low lift coefficients experienced in-orbit so far. Analysis has shown that surface materials which promote specular or quasi-specular reflections are able to strongly increase the magnitude of the available differential lift forces. An influence of advanced surface materials on respective maneuver sequences, however, has not yet been analyzed at all. In addition, the robustness of the differential lift based controller proposed up to now is questionable and not able to cope with the occurring uncertainties and dynamic variations. This paper aims to address these two research gaps. To do so, a robust control approach based on Lyapunov principles developed by Pérez and Bevilacqua for the differential drag based control of the in-plane relative motion is used in a second control phase to the control of the out-of-plane relative motion via differential lift. In a successive second step, the influence of energy accommodation on the full rendezvous maneuver sequence is analyzed. During the maneuver, the drag and lift coefficients are dynamically calculated using Sentman's gas-surface interaction (GSI) model based on the current environmental conditions. The results show that even a modest reduction in energy accommodation strongly reduces the maneuver times as well as the resulting orbital decay. In all analyzed cases, the proposed control approach led to a successful rendezvous.