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STABILIZATION AND REMOVAL OF THE SPINNING DEBRIS USING SINGLE-TETHERED SPACE-TUG SYSTEM

Abstract

Tethered space-tug (TST) system is considered as one of the most promising active debris removal technologies to effectively decrease the increasing population of space debris. In the TST system, the spinning debris poses a great challenge to the removal process as it may result in chaos behavior of the whole system. Thus oscillation suppression is crucial to ensure a stable deorbit process. To tackle this issue, double tethers, even four tethers are employed to control the debris by regulating the tether length alternately. It is obvious that the more tethers the TST system has, the easier the stabilization will be. Thus, the toughest part goes with the single tether oscillation suppression of the spinning debris. Inspired by the double-tethered control law and the offset control of the spinning debris, this study copes with the attitude stabilization of the debris and the tug using single tether by regulating the tether length and the tether attachment point on the debris. Therefore, a double-tether performance is imitated by a single tether with variable attachment point. In this research, a precise dynamic model in which the debris and tug are both regarded as rigid bodies is developed to study the dynamical evolution of both the debris and tug. Firstly, the relative motion equation of the system is described using Lagrange's equation and the orbit motion equation is derived by utilizing modified equinoctial elements. Secondly, the dynamic characteristic of the unstable system is simulated and a feedback linearization control law is proposed to stabilize the spin of the debris and tug by exploiting the tether offset variation and the regulation of tether length. Finally, the attitude stabilization and deorbiting effectiveness of the proposed scheme is demonstrated via numerical case studies.