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EXPLOITING LUNISOLAR PERTURBATIONS USING THE GRAZING METHOD: AN ORBIT CONTROL STRATEGY FOR A SATELLITE IN A CRITICALLY-INCLINED HIGHLY ECCENTRIC ORBIT AROUND THE EARTH

Abstract

Lunar and solar perturbations, coupled with the oblateness effects of the Earth, cause large predictable oscillations in the eccentricity and argument of perigee of critically-inclined highly eccentric orbits such as Molniya or Tundra orbits. These oscillations can be controlled in an efficient manner using the analytically-predicted knowledge of the perturbations and by determining the time at which the slope of the orbital elements is zero, which is called the switch point time. An orbit control strategy is developed that maintains the two orbital elements within a control range by performing a corrective manoeuvre to adjust the elements whenever they reach their maximum or minimum allowable state. The size of the manoeuvre is designed to ensure that the time when the orbital element approaches the limit of the allowable range coincides with the switch point time. The lunisolar perturbations will then direct the eccentricity or argument of perigee back towards their nominal value. This allows the orbit control strategy to minimize the amount of ΔV needed to maintain the orbital elements by exploiting the natural perturbations caused by the Moon and Sun. The paper develops the theory behind this novel control approach, presents sample simulation results, and discusses the ways in which this control strategy can be utilized to maximize the exploitation of the lunisolar perturbations on the eccentricity and argument of perigee.