

ASTRODYNAMICS SYMPOSIUM (C1)
Orbital Dynamics (1)

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HOW TO ESTABLISH AND KEEP ORTHOGONAL CONSTELLATION BY TWO ORBITERS
UNDER PERTURBATION

Abstract

This paper describes how to establish and maintain an orthogonal constellation by two orbiters. We assume the constellation where one orbiter looks down upon the orbital plane of another from the apoapsis, or the normal vector of one orbiter and the eccentricity vector of another are parallel. There have been demands and requests for such orthogonal constellation composed by an in-situ observation orbiter and a remote-sensing orbiter in studies of planetary atmosphere. Since their orbits can be perturbed by several external forces, they must be designed carefully so as to keep orthogonality. In this paper, we introduced the "Orthogonality Index" by using orbital elements of two orbiters, which provides us a quantitative index for orthogonality of the two orbits. By differentiating the index with respect to time, we derived several conditions to keep orthogonality via a bottom-up approach. They were well coincident with the top-down results derived in our former approach. Four solutions for the inclination of the remote-sensing orbiter were derived, which is independent from orbit shapes or central celestial bodies. If we assume planets with a relatively large J2 term such as the earth or the mars, the orbital elements for the in-situ orbiter can also be calculated easily. Numerical simulation results for orbiters around several planets were shown to validate the proposed method. It was also implied that small deviation of inclination from the ideal condition can be permitted. How to establish such orthogonal constellation with a large inclination difference is another difficult task. The strategy to transfer to the final orbit after simultaneous insertion into the highly elliptical initial orbit was discussed. It was indicated that utilization of natural forces such as precession by the J2 term or aerobraking can save much fuel consumption. A scheme to control the precession rate appropriately by altitude maneuvers for effective establishment of the orthogonal constellation was introduced. A possible maneuver plan for orbiters around the mars was also shown.