ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (2) (4)

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CMG GIMBAL ANGLES PLANNER BASED ON RAPIDLY-EXPLORING RANDOM TREES ALGORITHMS

Abstract

The next generation of optical and radar Earth-observation LEO satellites will require the capability of rapid spacecraft orientation manoeuvres, with angular rates up to 10 Deg/s, in order to achieve high resolution images, 3D images, and to improve revisit time capabilities. For these applications the usage of high torque actuators is mandatory and the Control Moment Gyros (CMGs) are the best candidate. The use of an array of CMG for the spacecraft attitude control needs to develop specific steering laws in order to avoid singularity problem inherent to redundant single-gimbal CMG systems. As solution to this matter, in this paper it is presented an off-line gimbals angle planner based on Rapidly-exploring Random Trees (RTT) algorithms. The RRT algorithms have been already extensively studied and successfully applied in the frame of robotic and airplane trajectory planning, but rarely applied to spacecraft attitude planning and never proposed as solution to CMG control. The usage of a CMG off-line planner permits to achieve several advantages respect to classical real-time control laws: first of all it permits to achieve benefits in terms of singularity avoidance. In facts, the RRT seeks the solution in a subset of state space by excluding all those solutions that are corresponding to a singular configuration; until the final target is reached. Moreover this kind of planner would benefits of several properties of RRT algorithms like the rapid exploration of all the state space and the assured convergence to the target solution if any. In this paper are given details about a CMG RRT planner that has been developed in Matlab; the adaptations of the classical RRT techniques to the particular CMG control problem are also reported. Therefore, numerical simulations of typical spacecraft slew scenarios are shown in order to underline performances and advantages of the proposed control method with respect to classical CMG steering laws.