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GOAL-ORIENTED PLANNING AND PATH PARAMETERIZATION FOR TIME-OPTIMAL SPACECRAFT REORIENTATION

Abstract

The fast attitude reorientation maneuver capability of spacecraft is required in many space missions. It is difficult to solve time-optimal attitude reorientation with respect to pointing constraints and bounds on control torques and angular velocities, because the solution is related to complex nonlinear planning problem. This paper addresses the problem of time-optimal spacecraft reorientation under bounded and pointing constraints. A two-step procedure is developed to avoid the piecewise rest-to-rest process. Firstly, a novel goal-oriented planning method based on random obstacle avoidance is proposed to quickly obtain a feasible attitude maneuver trajectory subject to all constrains. In order to reduce the generation of unnecessary paths and the number of random extensions, the rotation towards the final target will be solved at the start of the planning procedure and after each random obstacle avoidance that will be adopted if any pointing constraint is violated. The incremental eigenaxis rotation and discretized inverse dynamics are utilized as the uniform trajectory generation approach for fast solving all rotations towards the last goal or the random intermediate target. At each shortcut iteration subsequently, the time-optimal path parameterization algorithm is presented to minimize the maneuver time along the trajectory. Simulation results demonstrate that the proposed goal-oriented planning method can efficiently process multiple complex constraints. The computation of the minimum time reorientation with the shortcut iteration technique leads to near-optimal solutions. The total running time is faster than the three-step plan-and-shortcut method. Additionally, the computation speed of the goal-oriented planning method is better than the rapidly-exploring random tree algorithm in the three-step plan-and-shortcut method.