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TIME-OPTIMAL SPACECRAFT REORIENTATION UNDER MULTIPLE CONSTRAINTS VIA AN EFFICIENT HYBRID OPTIMIZER

Abstract

The fast spacecraft reorientation is required in many space missions. However, the spacecraft attitude maneuver will be limited by various constraints. The presence of multiple complex constraints will largely reduce the feasible attitude space and will greatly degrade the solving efficiency of the optimization algorithm. Hence, it is difficult to solve the time-optimal spacecraft reorientation under bounded and pointing constraints. It is also a great challenge to achieve rapid optimization for the problem. For the potential of onboard application, the computational cost should be specially addressed besides the satisfaction of multiple complex constraints. This paper is devoted to developing an efficient optimization method for the time-optimal, constrained spacecraft reorientation. In order to obtain the globally optimal solution rapidly, a hybrid optimization method is designed in the paper. First, a locally optimal trajectory is quickly generated by the goal-oriented path planning and time-optimal path parameterization algorithms. In the goal-oriented path planning approach, the rotation towards the final target will be solved at the start of the planning procedure and after each random obstacle avoidance. To avoid reduplicative consideration about the bounds on control torques and angular velocities, the goal-oriented path planning approach only obtains a feasible attitude maneuver path satisfying both keep-out and keep-in constrains. Along the path, the time-optimal path parameterization algorithm is applied to obtain a fast maneuver trajectory satisfying bounded constraints. Subsequently, the locally optimal trajectory is provided as the initial guess in a pseudospectral optimizer, which can generate the final time-optimal solution. Simulation results demonstrate that the hybrid optimization method can achieve efficient optimization for the time-optimal, constrained spacecraft reorientation. The hybrid method is much faster than the pseudospectral method alone. The goal-oriented path planning and time-optimal path parameterization algorithms also have a good potential for onboard application with low computational resources.