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AUTONOMOUS CONTROL FOR ARBITRARY THRUSTER CONFIGURATIONS AND MASS PROPERTIES IN SPECIAL EUCLIDEAN GROUP SE(3)

Abstract

Most current methods for determining maneuvers and thrust firing sequences depend on explicit and predetermined commands generated by a combination of on-board systems and ground-based human-in-the-loop methods. For spacecraft and space structures with changing mass properties and thruster configurations, such as the Deep Space Gateway as it changes configurations throughout its lifetime, determining these commands can be time-consuming and computationally intensive. However, recent work within the Lie Group $\mathsf{SE}(3)$ has offered ways of autonomously determining the location, power, precision, and capabilities of thrusters in any arbitrary position. Furthermore, a method for determining thruster firing sequences based on an arbitrary control input (both translational and rotational in a coupled, 6-element vector) and arbitrary thruster configurations has also recently been developed. When combining these methods, any spacecraft with any mass properties and thruster configurations can be understood in terms of controllability limits and thruster firing sequences can be generated quickly and with low computational load, thus extending the autonomous capabilities of deep space missions. In this work, this method is presented and explored in terms of computational load, robustness in the presence of uncertainty, and overall accuracy. The capabilities of this method are also examined in the case of the Deep Space Gateway both in fully controllable configurations and uncontrollable configurations.