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Autonomous Rendezvous for Underactuated Spacecraft

Authors : Espen Oland

Abstract : This paper presents a solution to the problem of autonomous rendezvous for spacecraft equipped with one main thruster for translational control and three reaction wheels for rotational control. With fewer actuators than degrees of freedom, this constitutes an underactuated control problem, requiring a coupling between the translational and rotational dynamics to facilitate control. This paper shows how to obtain this coupling, and applies the results to autonomous rendezvous between a follower spacecraft and a leader spacecraft. Additionally, since the thrust is constrained between zero and an upper bound, no negative forces can be generated to slow down the speed of the spacecraft. A combined speed and attitude control logic is therefore created that can be divided into three main phases: 1) The orbital velocity vector is pointed towards the desired position and the thrust is used to obtain the desired speed, 2) during the coasting phase, the attitude is changed to facilitate deceleration using the main thruster, 3) the speed is decreased as the spacecraft reaches its desired position. The results are validated through simulations, showing the capabilities of the proposed approach.

Keywords : attitude control, spacecraft rendezvous, translational control, underactuated rigid body
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