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Quasi-Optimal Control for Path Constrained Relative Spacecraft Maneuvers Based on Dynamic Programming

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Abstract: Autonomous close flight and docking of a chaser spacecraft to a target are still challenging problems. In this paper the Hill–Clohessy–Wiltshire equations are taken as dynamic model and inverted, after a variable change, in order to be used by a control algorithm to drive the chaser spacecraft along a specified path. The path parameterization is performed by using cubic B-splines and by having the curvilinear abscissa as parameter. The proposed optimization algorithm uses dynamic programming to find quasi-optimal controls. The number of optimization parameters is drastically reduced by working only on the acceleration component along the vehicle trajectory. The shape of the path can be chosen according to the specific maneuver requirements. In particular, the optimization algorithm is split into a trajectory planner which generates the best tangential acceleration sequence through backward exploration of a tree of possible policies, and a control generator which inverts the parameterized dynamics in order to get the thrusters commands sequence. The optimization algorithm has been coded in Simulink as a library of embedded functions and has been experimentally proved to run in real time.

Keywords: *Satellites rendezvous; dynamic programming; dynamic inversion; cubic B-splines.*

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