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MODEL PREDICTIVE CONTROL STRATEGY WITH A DECREASING HORIZON INTERVAL FOR A REUSABLE LAUNCHER IN A LANDING SCENARIO

Abstract

The descending and landing problem of a Reusable Launch Vehicle (RLV) concerns a wide variety of factors to overcome, such as the instability generated due to the aerodynamic forces during the descend phases and the strict requirements for accurate pinpoint landing to be met with limited control authority. In addition, the Guidance algorithm needs to be continuously and rapidly updated, in order to cope with the dynamically changing conditions that the RLV can experience during the re-entry and landing phase. One of the key technologies being studied to solve this problem is Model Predictive Control (MPC). MPC uses a linearized model of the problem to obtain a solution of the scenario, given a specific landing time in the future, called the prediction horizon (PH). In this paper, a new strategy to manage the PH of a MPC scheme is proposed for the landing scenario of a RLV. This strategy considers an offline predefined interval of PHs to obtain a valid solution instead of a single predefined PH. This strategy guarantees a wider set of feasible solutions to be searched with a Convex Optimization methods, increasing the robustness of the algorithm at the guidance stage against uncertainties on the models. A simulation setup is introduced for the landing scenario of an RLV, including full simulation of translational and rotational dynamics, along with the control laws to actuate each of the actuators of the vehicle. The results of the presented algorithm are then shown for the landing scenario of the first stage of a rocket. A Monte Carlo analysis is performed along the initial conditions of the system to prove its suitability for the problem at hand and to determine the range of initial conditions for a successful landing.