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GUIDANCE COMMAND GENERATION AND NONLINEAR DYNAMIC INVERSION CONTROL FOR REUSABLE LAUNCH VEHICLES

Abstract

Future launch vehicle concepts and technologies for expendable and reusable launch vehicles are currently investigated by the DLR research projects AKIRA and X-TRAS. In particular, the winged *Liquid Fly-back Booster* concept LFBB based on an LOX/LH2 propellant combination for vertical takeoff and vertical landing (VTVL), as well as the delta-winged horizontal takeoff and horizontal landing (HTHL) concept AURORA based on an LOX/Kerosene propellant combination are considered in these projects. Because of the complexity and risks involved in on-line trajectory optimization, off-line reference trajectories are still considered important for tracking purposes. In that sense, the goal of this paper is to investigate an off-line and general-purpose guidance and control (G&C) architecture for preliminary studies of reusable launch vehicles. This is done by using trajectory optimization combined with MODELICA models for the generation of optimal guidance commands, and then trajectory tracking is performed by means of inner-loop feedback controls in terms of nonlinear dynamic inversion with prescribed desired dynamics. We showcase the advantages of this baseline G&C architecture in terms of early stability and controllability aspects during the preliminary design studies of an example configuration of a reusable launch vehicle investigated in the context of the research projects above mentioned.