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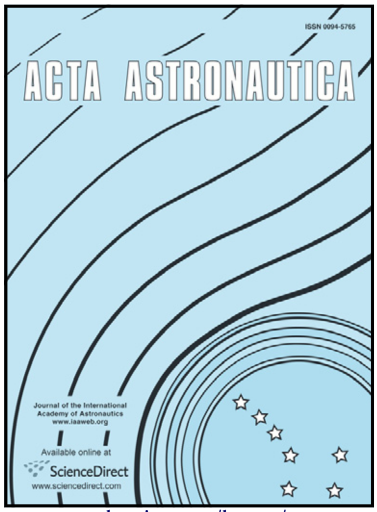

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Variable-Time-Domain Neighboring Optimal Guidance Applied to Space Trajectories

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Abstract: This research describes and applies the recently introduced, general-purpose variable-time-domain neighboring optimal guidance scheme, which is capable of driving a space vehicle in the proximity of a specified nominal, optimal path. This goal is achieved by minimizing the second differential of the objective function (related to fuel consumption) along the perturbed trajectory. This minimization principle leads to deriving all the corrective maneuvers, in the context of a closed-loop guidance scheme. Several time-varying gain matrices, referring to the nominal trajectory, are defined, computed offline, and stored in the onboard computer. Original analytical developments, based on optimal control theory and adoption of a variable time domain, constitute the theoretical foundation for three relevant features that characterize the guidance algorithm used in this work: (i) a new, efficient law for the real-time update of the time of flight (usually referred to as time-to-go), (ii) a new, effective termination criterion, and (iii) a new formulation of the sweep method. As a first application, this paper considers minimum-time lunar ascent and descent paths, under the flat Moon approximation. The second application is represented by the minimum-time, continuous-thrust orbit transfer between two coplanar circular orbits. In both cases, the nominal trajectories are two-dimensional, while the corresponding perturbed paths are three-dimensional. Specifically, perturbations arising from the imperfect knowledge of the propulsive parameters and from errors in the initial conditions are included in the dynamical simulations.