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# New Smoothing Optimization Technique for Continuous Low-Thrust Mission to Capture the Outer Planet

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## ABSTRACT

A well-founded approximation of the initial solution is a significant challenge in low-thrust trajectory optimization. There are several methodologies to deal with this difficulty. A new smoothing optimization technique based on the homotopy method is applied to deal with difficulties of indirect methods, i.e., extreme sensitive toward the initial guess and the small convergence radius. Such technique has been capable to enhance the possibility of achieving the global fuel-optimal trajectory, and to decrease the computational programming time. Consequently, efficiency is reasonably increased for the homotopy method process into the fuel-optimal interplanetary trajectory. Such method typically combines both new techniques of normalized initial costates and switching detection method throughout the algorithm procedure. The global convergence is guaranteed by normalization in the both first iteration to combine PSO and hybrid trust region algorithm, and also in the entire

iterations to utilization of the hybrid trust region algorithm for dealing with, respectively, the energy-optimal and the fuel-optimal continuous low-thrust scenarios.

The main example of this paper is to design fuel-optimal of continuous low-thrust nuclear electric propulsion mission to capture the outer planet, Jupiter. The results is more efficient compare to the former solutions with the same assumptions. We, once again, have improve the results via investigating on the hyperbolic excess speed in the same time of flight. The spacecraft, which is launched with a hyperbolic excess speed 0.6 km/s, is capable to preserve 577 kg propellant mass, about 3% of the total mission mass. The convergence accuracy of the optimization contained order-optimality $10^{-16}$. This paper is a prelude to the improvement of the new smoothing optimization technique based on the homotopy method.

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