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VARIABLE SPECIFIC IMPULSE LOW-THRUST LOW THRUST TRAJECTORY OPTIMIZATION USING HOMOTOPIC APPROACH

Abstract

The trajectory optimization problem with advanced variable specific impulse magnetoplasma rocket (VASIMR) engine using homotopic approach is studied. In practical case, the trajectory optimization problem must be treated under complicated conditions, such as energy supply, boundary conditions, limitations of the thruster magnitude and activation direction and the specific impulse. These conditions may make differences in difficulty of solving and the results of the optimal problems. The indirect method is an effective way to solve the fuel-optimal trajectory optimization problem, in which the homotopic approach is used to provide an effective initial value. Normally, the fuel-optimal problem with constant specific impulse is transformed to an energy-optimal one which can be solved efficiently with a nonlinear programming problem (NLP) solver. And the energy-optimal results are then continued to the desirable fuel-optimal ones by the homotopic algorithm. However, this method is no longer applicable in the case of variable specific impulse. The main work of this paper is trying to construct homotopic function which is applicable to variable specific impulse problems, improve the efficiency of solving, analyze and summarize the characteristics of optimal controller. Three representative trajectory optimization problems are solved. The first is an orbit raising problem from LEO to GEO; the second is a transfer from Earth to the Mars; the third is a transfer from an asteroid return to the earth. These three problems with different kind of constraints demonstrate the ability of VASIMR and efficiency of solving the trajectory optimization problems with homotopic approach. The purpose of this paper is trying to make a contribution to the homotopic approach in variable specific impulse trajectory optimization problems.