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Lunar Exploration (3)
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OPTIMAL FINITE THRUST LUNAR CAPTURE ORBIT OF NANO-SATELLITE

Abstract

Using the inexpensive nano-satellite will be one of the future development trend. Due to the low thrust and the limited fuel of the nano-satellite, the lunar capture orbit has unique design problems. In this paper, the finite thrust model is be used to study the lunar capture orbit of nano-satellite and optimal finite thrust capture orbit obtained by homotopy method. Firstly, the optimal three-pulse capture orbit is designed based on two-body dynamics model, including two periapsis maneuvers and one maneuver on a apoapsis. Then, the finite thrust model is established by modified equinoctial element. The indirect method is used to solve the two point boundary value problem(TPBVP) by using the Pontryagin maximum principle and the optimal control rate is obtained. Because the traditional indirect method needs the initial value of costate vector to be guessed reasonablely to obtain the feasible results, this paper concerns the application of the homotopic approach, which solves the fuel-optimal problem of finite thrust orbit by starting from the related and easier energy-optimal problem. Besides, a multi-circle splicing optimization strategy is proposed, which separates the capture orbit and solve the combination of shooting functions by reducing the orbital eccentricity gradually. Finally, the optimal control results obtained by homotopy method are compared with the results calculated by speed reverse direction control strategy, and the orbital parameters are analyzed. The simulation shows that the results obtained by homotopy method and multi-circle splicing are more efficient compared with the results of reverse direction control strategy, and the control low is conform to the bang-bang structure accurately. In addition, the probability of finding the globally optimal solution is improved.