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A STUDY ON LOW-COST AND FLEXIBLE DEEP SPACE EXPLORATION UTILIZING A CONCEPT OF INTERPLANETARY PARKING ORBIT

Abstract

This study aims to realize low-cost and flexible deep space exploration utilizing a concept of interplanetary parking orbit. In this study, it is assumed that 800 kg dual launch system consisting of 500 kg deep space explorer and 300 kg small kick stage is launched together with a primary payload into geostationary transfer orbit, GTO, whereupon the small kick stage is initiated at perigee to inject the deep space explorer into an orbit whose orbital energy, C3, is almost zero. Then the on-board ion engine system, IES, accelerates the explorer through the electric delta-V Earth gravity assist, EDVEGA, scheme to increase the Earth relative velocity at the Earth re-encounter point, which enables the explorer to inject into a transfer orbit to a deep space destination after the Earth gravity assist. The assumed destination in this study is the Mars however the suggested method can be applied to near Earth asteroids exploration and other deep space exploration missions. The Japanese H-2A 204 has ability to launch 6 tons of payload into GTO, accordingly, the 800 kg dual launch system can be launched together with about 5 tons of primary payload. Throughout the simulations conducted in this study, it is revealed that the assumed dual launch system can send the 500 kg deep space explorer equivalent to HAYABUSA-2 to Mars. The dual launch system suggested in this study has possibility to decrease the cost and also to increase the opportunity of deep space exploration missions. However, the launch window, which is critical for deep space missions, is severely constrained in the suggested launch configuration because the launch epoch is basically determined by the requirement of the primary payload. To solve this problem, this study suggest a concept of interplanetary parking orbit to increase the flexibility of deep space orbit design and to expand the launch window.