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INTERPLANETARY TRAJECTORY STUDY AND SPACE TRAJECTORY DEMONSTRATOR (STD 1.0) DEVELOPMENT FOR DEEP SPACE EXPLORATION

Abstract

Recently, leading spacefaring nations such as the United States, Japan, and the European Space Agency (ESA) are actively conducting or planning deep space exploration. In particular, asteroid exploration that threatens the Earth or has high commercial value, Sun-Earth L4/L5 exploration, and Mars exploration are core areas of deep space exploration that are receiving worldwide attention. Deep space exploration requires not only advanced space exploration technology but also very high development costs, so it is very difficult and burdensome for mid-level space development countries to readily conduct deep space exploration. The objective of this study is to acquire the core trajectory design technology necessary for deep space exploration in advance and to conduct a deep space mission using a low-cost, CubeSat level Space Trajectory Demonstrator (STD 1.0). By doing so, the study aims to enhance the likelihood of success for future missions and establish the foundation for the development of deep space probes. The STD 1.0, which is currently under design, weighs approximately 50 kg to 95 kg and have a size of less than 30U. The propulsion system of the demonstrator is being considered in two types: low-thrust and high-thrust, and the optimal thruster will be selected depending on the exploration target. The propulsion system of the STD 1.0 is being considered in two types: low-thrust and high-thrust, and the optimal thruster will be selected depending on the exploration target. The potential deep space exploration targets under consideration include the asteroid Apophis, the Sun-Earth L4/L5 points, and Mars. To determine the most effective approach, a trade-off study has been conducted to analyze optimal transfer trajectories and assess the advantages and disadvantages of each mission scenario. In addition, an alternative mission being considered involves launching the demonstrator into low Earth orbit using the Nuri rocket in the second half of 2027. Afterward, the spacecraft would use a low-thrust propulsion system to transfer to a geosynchronous orbit. From this orbit, it would capture images of Apophis as it approaches Earth. The main purpose of this mission is to demonstrate technology using a low-thrust engine, with the addition of an Apophis photographing mission.