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DESTINY+ LOW THRUST TRAJECTORY DESIGN FROM EARTH ORBIT TO ASTEROIDS FLYBY

Abstract

DESTINY+ (Demonstration and Experiment of Space Technology for INterplanetary voYage, Phaethon fLyby and dUSt analysis) is a small-sized high-performance deep space vehicle proposed at ISAS/JAXA. DESTINY+ will be an official JAXA project this year. The trajectory design of DESTINY+ is divided into several phases. First phase is an orbit injection into an extended elliptical orbit launched by the Epsilon rocket with the additional solid kick motor. Second phase is many revolutions transfer to raise apogee altitude by low thrust propulsion system to the moon orbit nearby. And at third phase, the distant flyby and the swing-by around the moon is designed to give DESTINY+ momentum to escape Earth gravitational field. At an interplanetary phase, DESTINY+ goes to an Asteroid Phaethon for flyby observation. After the Phaethon flyby, DESTINY+ is planned to go back toward Earth for gravity assist and go to another asteroid 2005UD which thought to have split from Phaethon. DESTINY+ has several mission objectives, including demonstration and experimentation of space technology for interplanetary voyages; and the investigation of the process to the end of evolution of a primitive body; the limitation of initial state and the evolution process of the meteor shower dust for science missions. This paper discusses DESTINY+'s low-thrust trajectory design and the related system analysis. As for the many revolution transfer phase, the low-thrust trajectory is optimized by the multi-objective optimization using genetic algorithm. In this phase, we minimize the time of flight, the passage of time of radiation belt, the work time of low thrust propulsion system and the maximum eclipse period. After the spacecraft reaches to the moon's path, it utilizes the moon swing-by several times to connect to the transfer trajectory for Asteroid Phaethon. Parallel to the trajectory design, the radiation effect analysis, thermal environmental analysis, attitude analysis and ground station visibility analysis for operation are achieved. From these studies, we can show the feasibility of the mission design of DESTINY+.