Paper ID: 17588
oral

ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimisation (2) (7)

Author: Prof. Vyacheslav V. Ivashkin
Keldysh Institute of Applied Mathematics, RAS, Russian Federation, ivashkin@keldysh.ru

Dr. Igor V. Krylov
Bauman Moscow State Technical University, Russian Federation, krylov_i_v@mail.ru
Ms. Anqi Lang
N.E. Bauman Moscow State Technical University, Russia, China, seatu_angel@126.com

OPTIMAL SPACECRAFT TRAJECTORIES FOR EXPEDITION TO ASTEROID APOPHIS WITH RETURN TO EARTH

Abstract

Asteroid Apophis will have in this century some approaches with the Earth. There is even any small positive probability of the Apophis-Earth collision. Because of this, the Apophis investigation by the SC devices and an analysis of the asteroid matter in the Earth laboratories are actual. So, a space expedition to Apophis is supposed to be perspective. Energy optimal trajectories for the expedition including a flight to asteroid Apophis, staying there during some time and following return to the Earth are investigated in the paper. Rocket Soyuz is proposed to be used for this expedition. Two groups of the flights are studied here. One group is composed by the SC flights that use a high thrust chemical engine for escape and a low thrust electric-jet engine for interplanetary flight. Optimal trajectories with maximal final mass are determined here using a developed hybrid method of space trajectories optimization. This method combines R.E. Bellman, F.L. Chernous'ko and N.N. Moiseev direct methods as well as L.S. Pontryagin maximum indirect method. Parametric continuation of solution is used, too. An analysis is performed for cases of both an ideal thrust without its value limitation and a real limited piecewise constant one. Another group is formed by the SC flights that use usual high thrust chemical engines only. The trajectories for flights between the Earth and Apophis orbits are determined here on the base of the Euler-Lambert problem solution. There are determined optimal trajectories and their characteristics for the expedition from Earth to Apophis and back in both groups of the flights during 2019-2022 years. Comparative analysis of these variants of flights is performed. The expedition may be realized in both cases of engines, although the payload mass is more for using electric jet engine.