Paper ID: 31792
oral

ASTRODYNAMICS SYMPOSIUM (C1)
Mission Design, Operations & Optimization (2) (5)

Author: Dr. Bruno Sarli
Japan Aerospace Exploration Agency (JAXA), ISAS, Japan, bruno.ren@gmail.com

Dr. Yuichi Tsuda
Japan Aerospace Exploration Agency (JAXA), Japan, tsuda.yuichi@jaxa.jp

A HAYABUSA 2 EXTENSION PLAN: ASTEROID SELECTION AND TRAJECTORY DESIGN

Abstract

After the success of Hayabusa JAXA planned and launched on 3rd of December 2014 its second asteroid sample return mission, Hayabusa 2. The mission targets a C-type asteroid "Ryugu" to study the origin and evolution of the solar system as well as materials for life. Hayabusa 2 was launched in a near 1:1 resonant orbit with Earth and performed a gravity assist one year later changing the spacecraft orbital inclination. Hayabusa 2 uses its ion engines to maneuver in deep space and rendezvous with the asteroid 1999 JU3. After an exploration campaign in the asteroid that will last roughly 18 months, the mission returns to Earth and releases a capsule containing material collected from 1999 JU3 for further analysis. This study presents one of the mission's extension scenarios after the capsule release and its return to deep space. Several hours prior to the atmospheric entry, Hayabusa 2 releases the capsule and performs some chemical burns that define its new trajectory after the final Earth encounter. The mission remains with roughly 20 Kg of Xenon that combine with the vehicle powerful ion engines can be used to steer the spacecraft to explore a new target.

This work uses a combination of linear dynamics, optimal control and reachability theory to find potential targets and design a flyby trajectory taking into account the full asteroid database. The method for asteroid selection is based on a 5 step process that progressively eliminates targets that are impossible to reach, also providing an estimation of the trajectory states, costates and thrust profile. Once the initial selection is made, asteroid and orbit characteristics, such as final mass, SPV angle, H magnitude, asteroid spectrum type and navigation time, are taken into account to further narrow the selection. Finally, an indirect method optimization based on the primer vector is used to calculate the minimum mass trajectory to the target. Results are then verified using a high fidelity direct method optimizer. A set of possible targets and it associated trajectory are defined through this method for the Hayabusa 2 extension mission. The final application of these results will of course depend on a successful Earth return and a proper execution of the pre-entry maneuvers.