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Author: Dr. Antonio Fernando Bertachini Almeida Prado
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, antonio.prado@inpe.br

USING UPGRADED VERSIONS OF CLOSE APPROACH MANEUVERS AS TRANSPORTATION SOLUTIONS FOR DEEP SPACE MISSIONS

Abstract

Gravity-Assisted maneuvers have been used as a technique to reduce fuel consumption in deep space missions for several decades now. It opened the doors of the exterior solar system. The literature shows those results, as well as new versions of this maneuver, which includes: the use of propulsion combined with the close approach, both high or low thrust; the passage by the atmosphere of a planet to help to change the trajectory of the spacecraft; the use of tethers to increase the changes in the velocity of the spacecraft. All those new versions have the goal of increasing the variations of energy given by the maneuver, making possible missions that would not be without this technique. In that sense, the main goal of this paper is to make a detailed survey about those options, considering the best situations to apply each of them. In particular, the use of tethers is theoretical very promising, both in terms of giving extra energy to the spacecraft as well as making possible the use of smaller bodies for the closest approach. It gives much more flexibility to mission designers, which can plan missions using a large variety of smaller celestial bodies such as asteroids and even comets as a final goal of the mission or an intermediate step to observe the body and to get extra energy for the spacecraft. The idea of the construction of an "Escape Portal" and a "Capture Portal" using tethers has also been discussed in the literature, showing large gains in terms of energy used for a spacecraft. The idea is to use tethers based maneuvers to send the spacecraft to the exterior solar system and also to capture that spacecraft after reaching its destination. The construction of this portal would allow an unlimited number of maneuvers using the same tether and celestial body, which would be very beneficial for deep space missions using small satellites. This structure would be formed by a tether that remains fixed in an asteroid. At the other end of the tether, a large net is fixed, such that the only action required from the spacecraft to make the maneuver is to hit the net. New results and results obtained from the current literature will exemplify those missions, helping to guide a future mission designer to choose the best options for a given mission.