

NEAR MOON GRAVITY ASSIST MANEUVERS AS A TOOL FOR ASTEROID CAPTURE ONTO EARTH SATELLITE ORBIT

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Abstract: Gravity assist maneuvers have become broadly applied technology for contemporary spacecraft missions allowing sufficiently to decrease demanded amount of propellant. Efficiency of such approach looks even more impressive for the cases when it is used for small near Earth asteroids motion control when the latter are targeted to hit hazardous sky objects in order to deviate them from Earth collision using kinetic impact. In the paper the similar methods are proposed for solution of the problem to capture asteroid onto Earth satellite orbit.

Described in the paper methods do not demand to fulfill high rocket dynamics maneuvers, in our case these maneuvers are restricted by delta $-V$ values less than 20-30 m/s. To reach such characteristics the following flight dynamics operations are executed. After delivering spacecraft on the surface of the asteroid and its anchoring, some small delta $-V$ is applied which transfers asteroid to trajectory of gravity assist maneuver near Earth. The goal of this maneuver is to put asteroid onto the orbit resonant with the Earth orbital motion. In the paper the list of asteroids from the JPL minor planets catalog is given which is possible to transfer onto one year resonant orbits by applying delta $-V$ less than 20 m/s. Further the procedure of these asteroids transfer onto other orbits keeping their periods constant, including the ones with maximum inclination towards ecliptic plane, is described. The latter orbits are considered as those which are among most convenient for the further operations aimed to capture asteroids onto Earth satellite orbits. This procedure consists from multiple near Earth gravity assist maneuvers executed under condition that after each maneuver the orbit is kept to be resonant. Some examples of the orbits which are possible to reach during such maneuvers are presented for real asteroids from minor planets catalog.

Paper includes methods and algorithms which allow to construct the sequence of operations and their characteristics resulting in transfer of asteroid from resonant orbit onto Earth satellite orbit i.e. capture of asteroid. Qualitative analysis of the windows of maneuvers possibility is presented taking into account the box of reachable control parameters which are to be chosen during operations execution. It should be mentioned use of only single near Moon gravity assist maneuver to capture asteroid on Earth satellite orbit demands rather low relative velocity with respect to Earth. This requirement, i.e. to capture asteroid using only one Moon flyby, drastically reduces the possibilities to realize this approach. To overcome this obstacle one needs to execute proposed multiple near Moon gravity assist maneuvers. It is shown in the paper that with described conception it is possible to capture onto Earth satellite orbit any small near Earth asteroid (or its fragment) from the list of mentioned above ones which may be transferred onto resonant orbit. The results of applying such conception is demonstrated by presenting several asteroids capture onto Earth satellite orbit.