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Space Transportation Solutions for Deep Space Missions (8-A5.4)

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CISLUNAR TRANSFER ORBIT DESIGN FOR NANOSATS

Abstract

Nanosats have been demonstrated the capability of deep space exploration with the availability to onboard control systems, such as propulsion, active attitude control, navigation as well as communication, thermal or other subsystems design required for deep space. As usual, they are launched as second payloads into many kinds of deployment orbits. In this paper, aiming at lunar exploration with nanosats, two concepts that nanosats transfer to the moon from deployments in low earth orbit (LEO) and geosynchronous transfer orbit(GTO) respectively are put forward. In the orbit design, both dynamical system approach and low thrust model are used to realize low energy cost orbit transfer in order to satisfy the limited condition of propulsion subsystems. The first deployment is from LEO. The nanosats need a departure velocity to come into an intermediate transfer trajectory, then a matching delta velocity is required when the transfer trajectory encounters the local earth-moon manifold which can flow towards the moon or a libration point orbit with zero or low cost. Finally, delta velocity for lunar orbit insertion is used for maneuvering intro lunar orbit. It is noteworthy that the departure velocity can be supplied by launch vehicle and the other delta velocities are feasible with a low trust model whose propulsion can be provided by low thrust Solar Electric Propulsion (ESP). The second one is from GTO, which is similar to the former concept. The nanosat is placed into an intermediate orbit by making full use of the upper stage of the geostationary satellite launch vehicle, then utilize a local Earth-Moon manifold to have a natural flow to the Moon or into a libration point orbit. The location in the GTO from which to attain the intersection with the manifold is optimized and several options are provided to demonstrate feasibility. In conclusion, two cislunar transfer concepts which can be applied in the low cost nanosat missions are proposed. The orbit design method used in this paper can be expanded to other low cost deep space explorations and it will also contribute to the application of nanosats in deep space.