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LOW-COST ASTEROID MISSION OPPORTUNITIES USING VENUS GRAVITY ASSIST

Abstract

We investigate design opportunities for interplanetary exploration probe by means of a piggy-back launch on the Japanese H-IIA rocket. This paper mainly discusses the mission trajectory design and delta-V estimates. In this case, the probe's orbit is determined by the main passenger's orbit. The probe mass must be less than 50 [kg] and its volume must be smaller than 50 50 50 [cm]. Therefore, we have severe limitations in terms of delta-V that can be generated and we have to look for targets which we can reach with small delta-V. In particular, we focus on the effect of the injection errors on the mission trajectory in this paper. This paper assumes the piggy-back opportunity of the Planet-C mission as an example. This is a Venus explorer mission which will be launched in 2010. The H-IIA launcher provides opportunities for 3 piggy-back satellites in Low Earth Orbit and one piggy-back probe will be launched in a Venus transfer orbit. We consider an asteroid flyby mission using a Venus and possibly also an Earth gravity assist. After the separation of the main passenger, the rocket maneuvers in order to avoid collision with the second stage. Then, the piggy-back probe is injected into an orbit towards Venus. The probe's orbit is a little different from the main passenger orbit because of the separation time difference and the probe's characteristics. We calculate the injection error from the thrust time, thrust direction and magnitude. In addition, we also consider the probe's separation time errors, direction errors and other potential error sources. First, we calculate the trajectory without injection error. Next, we calculate the trajectory including injection error and we discuss how the errors change the mission trajectory including the Venus gravity assist performance. In this phase, we also discuss each source effect on the trajectory individually. Finally, we calculate the required delta-V values which are needed for error corrections and propagate the trajectory when including the error corrections and compare with the free-drift cases.