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DEVELOPMENT AND TESTING OF AN ENGINEERING MODEL FOR AN ASTEROID HOPPING ROBOT

Abstract

The science and origins of asteroids is deemed high priority in the Planetary Science Decadal Survey. Two of the main questions from the Decadal Survey pertain to what the "initial stages, conditions, and processes of solar system formation and the nature of the interstellar matter" that was present in the protoplanetary disk, as well as determining the "primordial sources for organic matter." Major scientific goals for the study of planetesimals are to decipher geological processes in SSSBs not determinable from investigation via in situ experimentation, and to understand how planetesimals contribute to the formation of planets. Ground based observations are not sufficient to examine SSSBs, as they are only able to measure what is on the surface of the body; however, in situ analysis allows for further, close up investigation as to the surface characteristics and the inner composure of the body. The Asteroid Mobile Imager and Geologic Observer (AMIGO) is a 1U stowed autonomous robot that can perform surface hopping on an asteroid with an inflatable structure. It contains science instruments to provide stereo context imaging, micro-imaging, seismic sensing, and electric field measurements. Multiple hopping robots are deployed as a team to eliminate single-point failure and add robustness to data collection. An on-board attitude control system consists of a thruster chip of discretized micro-nozzles that provides hopping thrust and a reaction wheel for controlling the third axis. For the continued development of the robot, an engineering model is developed to test various components and algorithms. Three enabling technologies for the mission are tested. One of the primary components is the inflatable structure that enables context imaging, communication with a mother spacecraft, and solar collection. The other two components tests are for a small reaction wheel system and the MEMS thruster assembly. The inflatable, once properly deployed, is filled with helium to provide a buoyant force simulating micro-gravity conditions and the attitude control system is tested. One algorithm to be tested is organized motion planning to efficiently explore the surface of a simulated asteroid. To enable this path planning, the stereo camera must provide context imaging and the system autonomously determines a point of interest to hop to.