30th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Spacecraft for Deep-Space Exploration (8)

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HIGH-TECHNOLOGY OPERATION FOR PLANETARY EXPLORATION - URANIAN MOONS IMPACTOR (HOPE-ROAR) MISSION: AN INNOVATIVE IN-DEPTH STUDY OF THE URANIAN SATELLITES

Abstract

Within our solar system, ice giants such as Uranus have long remained discarded for in-depth research with a dedicated spacecraft mission. Uranus has only been briefly visited by the Voyager 2 spacecraft, whose flybys occurred over 30 years ago. Uranus is an ideal target as it has its own idiosyncrasies - the study of which may answer questions that are fundamental to humanity's understanding of ice giants. As noted in the 2023-2032 Planetary Science Decadal Survey, a mission to Uranus is feasible with currently available launch vehicles and an optimal trajectory window in the 2030's.

This paper proposes the addition of multiple rideshare CubeSats to expand the science objectives of the Uranus Orbiter and Probe (UOP) mission. The paper will describe each subsystem design with emphasis on how it addresses the challenges introduced by the extreme environment of Uranus. In particular, the lack of solar availability provides many constraints for power generation and distribution, impacting instrumentation and mission duration. Moreover, the distance between Uranus and Earth creates challenges in communication, and lack of supporting satellite systems complicates CubeSat navigation. Therefore, the paper will also discuss our analysis of these identified challenges to better understand their impact on the mission, and our innovative technical solutions based both on commercial off the shelf (COTS) technology and new research under development.

The objective of the HOPE-ROAR mission is to perform an in-depth study of the large Uranian satellites that comprise the only natural satellite system that has not been intensively studied by spacecraft. The primary objective is to map the global properties of large Uranian moons (surface morphology, composition, internal heat sources, and subsurface water distribution) and investigate how the properties of the Uranian moons constrain their formation and evolution. This mission concept proposes an ideal scientific sensor suite, presenting a low-cost/fast-delivery space asset that can provide reliable scientific data on Uranian moons. In addition, this mission will demonstrate the viability of small satellite technology for deep space exploration and test new deep space technologies.

This work results from the work made by the HOPE (High-technology Operations for Planetary Exploration) Research Unit of the ACHIEVED (Assembly for Concepts in Human Interplanetary Exploration with Various Extraterrestrial Designations) initiative, under the guidance of the Space Exploration Project Group (SEPG) of the Space Generation Advisory Council (SGAC). This initiative enables students and young professionals to work, explore and collaborate on a space mission design project.