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DESIGN AND ARCHITECTURE OF ANUBIS: A HOPPER TO SAMPLE AND STUDY MERCURY'S SURFACE AND SUBSURFACE

Abstract

In the quest to unravel the mysteries of our cosmic neighbors, the focus is set on Mercury, the closest planet to the Sun. A new era of exploration and discovery awaits as a mission of unprecedented ambition unfolds, one that promises to change the understanding of this rocky world.

Over the years, several missions have investigated Mercury. Nevertheless, they only relied on orbiters, thus conducting remote studies of its surface. On the other hand, Anubis, the core element of the MIRAGE (Mercury In situ Regolith Analysis, Geophysics and Exosphere) mission, aims to outline a ground segment capable of exploring three distinct regions of Mercury's surface and subsurface allowing an unprecedented science return.

The surface of Mercury showcases distinct features characterized by the presence of smaller and larger craters, predominantly formed due to the impacts of minor celestial bodies. Mariner 10 and MESSENGER revealed interesting reflectance disparities on the surface caused by differences in composition. There are three different categories that can be classified as follows: ancient, heavily cratered terrain with an intermediate albedo; Lower-Reflectance bluish Materials (LRM); Higher-Reflectance reddish Materials (HRM). Caloris Basin has been selected as the primary landing site for the presence of planar regions with LRM and HRM in proximity and for its strongly magnetized nature.

The science objectives are satisfied by a hopper, an innovative vehicle capable of travelling more than 70 km across Mercury's surface thanks to its propulsion system. Through its jumps a series of different sites, firstly LRM, secondly HRM and finally a young crater, are sampled and studied, providing the analysis of most of the elements present on the planet.

The most revolutionary aspects of Anubis are the descent, landing and jumping capability, allowing enhanced mobility and needing for an innovative power source for surviving the harsh conditions. These characteristics underscore its superior capabilities when compared to traditional rovers.

A major challenge was the survivability on Mercury's surface, which experiences extremely high temperatures during the day. This was addressed by landing at dusk and conducting operations during night. Analysis on radiation, particles, seismic vibrations, magnetic field and chemical composition are performed. To collect the samples a drill was designed, with a capability of reaching up to 20 cm depth.

This paper reports about the outputs of phase A run by a team of 12 master students of PoliMi as part of the Applied Space Mission Analysis and Design course in space engineering.