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Moon Exploration – Part 2 (2B)

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QUALIFICATION OF A DUAL ROVER ARCHITECTURE INCLUDING DEPLOYABLE CAMERAS FOR EXPLORATION OF A SKYLIGHT ON THE LUNAR SURFACE.

Abstract

In the past several years, based on data from the Japanese Kaguya lunar orbiter and NASA's Lunar Reconnaissance Orbiter, there have been many discoveries of potential lava tube "skylight" entrances on the surface of the moon. The Google Lunar XPRIZE entrant, Hakuto, and the Space Robotics lab of Tohoku University successfully field demonstrated the use of an 8 kg parent rover and 2 kg tethered child rover to safely explore steep, rocky and vertical terrain like that expected at a skylight. We also qualified these rovers with thermal-vacuum, vibration and radiation testing. Based upon these results, we developed an additional 300 g deployable camera. This is suitable for integration on either of Hakuto's rovers, greatly reducing the total mass required to explore a skylight, and increasing the number of potential missions. The base configuration for the deployable camera consists of a passive, up to 100 m long tether loaded onto a motorized spool and a spring-loaded camera module. The camera module includes a small battery, micro-controller, mass storage device, and power/communication electrical contacts. When fully retracted by the motorized spool (located in the rover), a ratchet mechanism locks the module in the loaded position. In this position it can stream images to the rover's main controller via a serial connection. Upon release of the ratchet mechanism, a one-way clutch allows the module to freely travel as a projectile. Images captured at regular intervals are stored on-board the module until it is once again retracted and they can be transferred to the main controller. We built the camera module from commercial off-the-shelf components and proved the individual components and integrated system are suitable for a space mission through extensive simulation and testing. An additional configuration omits the spring-loaded mechanism and instead integrates the camera module into a rear-wheel in the trailing part of the nominally two-wheeled child rover. By building the two deployable camera modules for integration into our two lunar rovers, we have we have upgraded our dual rover architecture to include up to three redundant methods for returning images from a potential lunar cave, even where the entrance would be impossible for a conventional rover to traverse. This allows flexibility in mission architecture to meet the requirements of multiple lunar landing opportunities, multiple landing targets, and even a poorly described landing target.