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LUNADRONE: NANO DRONE FOR LUNAR EXPLORATION

**Abstract**

The LuNaDrone mission concept aims at exploring the entrance of a lunar lava tube by means of a small spacecraft capable of performing autonomous flights.

Access from the lunar surface to these volcanogenic underground channels may be provided through skylights, vertical pits formed by partial collapses of the lava tube ceilings. These pits are already of great scientific relevance and if they provide access to lava tubes, they would also be of great interest for human exploration as these caves would shelter from cosmic radiations, micrometeoroids, and extreme temperature swings. The LuNaDrone mission concept would provide both the opportunity to acquire data scientifically relevant to planetary science, and to assess the feasibility of establishing lunar outposts at these sites.

The proposed system relies on LuNaDrone, a compact spacecraft of 12U, which would land on the Moon aboard a host spacecraft (HSC). The HSC would provide power and communications to LuNaDrone until the start of the drone's operational phase, which would begin with the detachment from the HSC at no more than 1 km from the skylight. The drone is equipped with a monopropellant propulsion system and a range-visual-inertial navigation system that together would provide the spacecraft with the ability to perform a controlled flight that would include: reaching the skylight, descending into the pit, emerging from the skylight and landing at a site in line-of-sight with the HSC. During the flight, LuNaDrone would be able to acquire data concerning the morphology of the lunar pit and the accessibility conditions of the lava tube entrance. Although LuNaDrone is designed for the exploration of lunar pits, its ability to quickly transverse difficult terrain and acquire images from a high vantage point makes this type of spacecraft an ideal forward reconnaissance platform that would offer a broad range of scouting possibilities.

The LuNaDrone concept was conceived in response to the Artemis Accords signed by Italy and USA in 2020. The idea behind this project is to follow the approach taken for CubeSats in terms of standardisation and modularity, i.e. to meet the need for standard, flexible and low-cost drones for lunar exploration. The LuNaDrone project, which is led by the Politecnico di Torino with the involvement of selected Italian SME's under the aegis of CEIPIEMONTE (in particular for international relations), has been underway for two years and after the feasibility study is now tackling the development of the system with the prototype phase.