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PANGAEUS: SURVIVING THE LUNAR NIGHT-A COMMERCIAL LUNAR PAYLOAD SERVICE[CLPS] DEMONSTRATION

Abstract

We are headed back to the Moon, this time to stay. NASA's Artemis program has the ambitious goals of putting a woman and man on the Moon by 2024 and establishing a sustainable lunar presence. It is hoped that this prolonged activity will help us evolve sturdy and reliable systems to prepare us for long duration expeditions to Mars. Such goals are admirable, but they also mean there is a lot of data to be gathered there. The Pangaeus concept architecture addresses the precursory robotic activities to accomplish this goal. The Moon's extreme and harsh surface conditions make clear that robotics will be an integral part of any mission; especially those with sustainability in mind.

Good efforts are being made in lunar robotics through the Commercial Lunar Payload Services (CLPS) initiative, but none of them seem to directly address the most pressing issue, the extreme diurnal temperature variation. Temperatures on the lunar surface fluctuate much more widely and dip much lower than those on Earth, especially during the long lunar night. They can get as low as -173.15 C and last around fourteen Earth days, which is dangerously cold and prolonged, even for robots.

The Pangaeus concept addresses this critical problem by proposing a unique solution which takes advantage of one key fact. The lunar surface regolith is a good thermal insulator. At approximately 30 cm below the surface, the ambient temperatures are much more stable and survivable for electromechanical robotic systems. Though the Moon does not have a magnetic field or atmosphere to serve as initial thermal interfaces between it and the space environment, we can use what it does have – the surface regolith.

Pangaeus is a robotic architectural concept for lunar exploration that takes advantage of the surface regolith mass already present on the Moon to survive the frigid temperatures of the lunar night. By building a swarm of robots (small but collaborative, and large in number) and enabling them to dig beneath the lunar surface, this concept hopes to prove that subsurface dwelling is a viable method for surviving the lunar night, on the Moon.

In addition, this concept believes the swarm nature of the robots will allow them to robustly perform meaningful work using solar power during the lunar day, like preparing the surface for development or collecting regolith in preparation of 3D printing, thus finding a balance between thermal ruggedness and utility. It is proposed that all of this serves the Artemis program and is demonstrated as part of a CLPS mission with lunar night survival as the primary objective and useful work as secondary. Upon successful demonstration, the Pangaeus concept could very well kick off the process towards a sustainable, naturally protected subsurface human and robotic presence on the Moon.