IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Astrobiology and Exploration (6)

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ASTRO DOGS: FAST, RESILIENT, AUTONOMOUS LEGGED ROBOTS FOR THE SCIENTIFIC EXPLORATION OF PLANETARY BODIES.

Abstract

The current go-to mobility systems for planetary exploration are wheeled rovers, rugged and capable of carrying a heavy payload, yet limited to flat, gently-sloping terrains and agglomerate regolith. Here, we present 'Astro Dogs' (AD), robotic quadrupeds, the next evolution in mobility systems for extreme planetary exploration. An AD is a novel system concept for science acquisition and return from hard-to-access planetary regions, opening the door for next-generation Astrobiology missions to planetary subsurface regions. ADs can negotiate extreme terrains using unique failure-recovery behaviors in the event of a topple, providing a major breakthrough in planetary traversability. ADs are lightweight, compact, and fast-moving; compared to Perseverance (2.6% of 18m3 volume, 4.6% of 1025kg mass, 38 times faster at 5km/h). Additionally, ADs are capable of coordinating in a pack of multiple robotic units: 1x (Alpha-AD) equipped with an adaptable science payload capable of accommodating 5-10kg of equipment, including an arm; and 1x (Tether-AD) equipped with a tethering system for vertical pit descent. One of these units carries an MMRTG power supply to recharge its pack-mates throughout the mission. Each AD is equipped with deployable communication nodes to facilitate live, subterranean-to-surface transmission in subsurface mission contexts.

Astro Dogs operate in synergy, exhibiting collaborative mobility behaviours to accomplish diverse missions that cannot be fulfilled by a single robot. A potential future target for ADs are an array of lava tubes on the southeastern flank of Pavonis Mons in the Tharsis Region of Mars. This region is of interest to scientists as it offers access to the Mars subsurface, where evidence of past or extant life may persist, and a potential shelter to future human inhabitants.

The MD concept has evolved from our experience using legged platforms, most recently the Boston Dynamics "Spot" quadruped. We endowed Spot with a high-level autonomy/AI framework, "NeBula", developed by our JPL/Caltech Team, 'CoSTAR'. Our "Autonomous Spot" platform has advanced the current state-of-the-art in legged exploration and traversal of extreme and subsurface environments, propelling us to a 1st-place finish in the 2020 DARPA Subterranean Challenge.

We envision augmenting a similar quadrupedal system with our state-of-the-art 'NeBula' AI framework for Astro Dogs. Through partnership with the NASA BRAILLE Project, we have applied this technology

to planetary analog mission operations in volcanic caves in N. California. We will present our 2021 deployment results at the meeting.