"GLOBETROTTER-LUNAR" ALL-TERRAIN HOPPER: DIGITAL ANIMATIONS OF SURFACE AND SUBSURFACE EXTREME TERRAIN ACCESS. Angad Chhibber[1,2], Pascal Lee[1,3,4], and Joseph E. Riedel[5], [1]Mars Institute, [2]Dublin High School, [3]SETI Institute, [4]NASA Ames Research Center, [5]Jet Propulsion Laboratory. E-mail: angad_c@outlook.com

Introduction: GlobeTrotter-Lunar (GTL) is a concept for a low cost, light-weight, fast-moving all-terrain hopping instrument payload package for the exploration of the lunar surface and subsurface (pits and caves) [1, 2]. GTL is currently under concept study and prototype field testing at the Jet Propulsion Laboratory [3] in collaboration with the SETI Institute and the Mars Institute (Science PI: P. Lee). Variants of the GlobeTrotter (GT) system are also under study for the exploration of Mars, small bodies such as the moons of Mars, and other solid-surface planetary destinations [4, 5]. We present here the first digital animations of GTL exploring extreme terrain on the Moon, including for the reconnaissance of pits and caves, created as part of a high school student internship in the Mars Institute's Global Research Internship Program (MI-GRIP) [6].

GTL Concept: In its basic form, the GT design centers on a multi-cubesat-class avionics and payload core, shielded by an elastic and resilient open shell formed of a network or mesh of tensegrity structures. Larger versions of GT in which the central avionics and payload core are nested at the intersection of four tensegrity spheres, are patterned on the tetrahedral air-bag architecture of the Pathfinder and MER air-bag landing systems. GT's tensegrity shells provide both a means of surface compliance and shock reduction for a semi-soft landing, obviating the need for expensive and massive fully-soft landings, as well as robustness for extreme terrain access and locomotion, both across the surface and in the subsurface.

GTL would be capable of accessing and exploring any extreme terrain at the surface of the Moon. GTL would in particular be uniquely suited to explore lunar pits and caves, as the system would be robust against unknown subterranean roughness and cave geometries, offer rapid pit / cave ingress via passive bounces with minimal disturbance to the cave, and rapid propulsive egress minimizing time spent in the cold and dark subsurface environment [7].

In its single sphere form considered in this study, GTL could carry a payload of 5-10 kg, weigh a total of 50 kg, and rove rapidly across 10-15 kilometers to perform local investigations over the course of days.

GTL Digital Animations. To simulate GTL bouncing across the lunar surface, we used Python as the programming language and Python Turtle Graphics to create the animation. The Turtle programming library was used to display and move around graphics, for the actual animations.

Figure 1: GTL Digital Animation. Still frame from a video sequence showing the launch of GTL in its single sphere form as it roves across rough lunar terrain.

GTL digital animations created in this study can be viewed as a video posted on the Mars Institute website: www.marsinstitute.no/projects/globetrotter/videos/GTL

GTL Missions: GTL could be deployed on the Moon robotically or by human crew at the surface, including in the context of the Artemis Program. Potential scientific targets of interest in the lunar polar regions include Permanently Shadowed Regions (PSRs) over scales ranging from hectometers to tens of kilometers - including large PSRs such as Shackleton Crater near the lunar South Pole -, vast impact basins such as Schrödinger Basin or the South Pole-Aitken Basin, and clusters of pits and caves in large Copernican Era impact craters, e.g., Schomberger A [8,9].

A baseline instrument suite relevant to all targets above includes multidirectional array of color cameras, neutron spectrometer, multi-channel active-illumination near-infrared spectrometer, and radiometer [2-5, 7].

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