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LESSONS LEARNED FROM THE BREADBOARDING OF A HOPPING SCOUT ROBOT FOR LUNAR EXPLORATION

Abstract

This research considers the development of a novel robotic platform, called Galago, for delivering scientific instrumentation for in-situ geomorphology studies to the areas normally not accessible for rovers and providing the scout capabilities that would significantly lower the mission risk of exploring undulated terrains during lunar missions.

Small scout robots have proven their benefits in planetary exploration, as Philae, Minerva II, MASCOT and Ingenuity increased the science return of their motherships. Under the Galago project, we are investigating the use of such a system for the exploration of low gravity bodies, primarily the Moon, and hence easily scaled down to asteroids or comets. Based on our studies, Galago is suited to perform three lunar mission scenarios: (1) one-way, short-term mission (e.g. to the lunar PSR Shackleton Crater), (2) return mission accompanying the mothership (e.g. Rima Hadley), and (3) long-term and self-powered survival mission at the illuminated site (e.g. Ina Caldera).

The paper presents the current development status with architecture and high-level design, actuator and mechanical design, and electronics and software design. The design iterations bring lessons learned which are beneficial also to other robots of this type in general. For instance vectorization of hops and general scalability and modularity of the system. Particularly it is analyzed and discussed in the context of the actuator, the actuating leg, and leg configurations.

Also, the paper provides a valuable synthesis of the tests performed on two breadboard models of the actuating legs. These include the study and verification of the performance on various regolith analogue surfaces to identify energy dissipation factors during hopping interaction, e.g. cohesionless quartz sand, cohesive regolith analog, also heavy, and light rocks. Dependence of the performance on the actuating leg's surface contact area is also provided, suggesting it is beneficial to keep the contact area relatively large

to limit the energy absorption by the ground. Based on these test campaigns an algorithm is proposed in which a hopping movement prediction accuracy can be improved while indexing the surface mechanical properties at the same time. The proposed method may enhance the control and navigation strategies of hopping robots in general.

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