11th Asia-Pacific Regional Conference of the ISTVS
September 26-28, 2022 | Harbin, China | online

Why we need alternative ground robots to traverse sandy and rocky extraterrestrial terrain, and how we can progress towards them

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Abstract

Robotic spacecrafts and vehicles have helped expand human's reach in many planetary exploration missions. Most mobile ground robotic vehicles for planetary exploration use wheeled or modified wheeled platforms, and they have been extraordinarily successful at completing intended mission goals. However, due to the limitations of wheeled locomotion, these robotic vehicles have been largely limited to relatively benign, solid terrain with sparse obstacles, and they have avoided extreme terrain with loose soil/sand and cluttered large rocks. Unfortunately, such challenging terrain is often among the most scientifically interesting for planetary geology. Many animals traverse such challenging terrain seemingly at ease, but robots have not matched their locomotor performance and robustness. This lack is largely due to a lack of understanding of the fundamental principles of how effective locomotion (or lack thereof) is generated from controlled interaction with complex terrain, on the same level of flight aerodynamics and underwater vehicle hydrodynamics. Fundamental understanding of legged and limbless locomotor-ground interaction gained over the past few decades has already enabled stable and efficient bio-inspired robot locomotion on relatively flat ground with small, scattered obstacles. Recent progress in the new field of terradynamics of locomotor-terrain interaction has also elucidated the principles of legged and limbless locomotion on loose soil/sand via a diversity of surface and subsurface locomotor modes, as well as over cluttered large obstacles via destabilizing locomotor transitions across different modes overcoming obstacles comparable to or larger than robots themselves. Such bio-inspired multi-legged and limbless robots using terradynamic principles will provide versatile, robust alternative platforms for traversing scientifically important extreme extraterrestrial terrain and expand the reach in planetary exploration.

To learn more, see our recent open access paper: Li C, Lewis K (2022), The need for and feasibility of alternative robots to traverse sandy and rocky extraterrestrial terrain, ***Advanced Intelligent Systems***, doi.org/10.1002/aisy.202100195

Keywords: terrain mobility, planetary exploration, terradynamics, legged robots, limbless robots

Presenter: Chen Li