Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

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Counter-Rotating Archimedes Screw-Propelled Excavation Rover

Background

Efficient vehicle mobility in granular media is a challenge further compounded when the granular media is targeted for excavation and located on a non-Earth body. Adding to the complexity of the problem is the wide variety of granular materials that exist. Many of these materials make locomotion difficult and cause wheel slippage, diminished traction, and clogging of robotic joints. Treaded or belted vehicles have limited utility in environments with harsh UV radiation and operation is highly susceptible to the detrimental effects of dust. These issues motivate new mobility and material transfer solutions in the space sector where heightened emphasis is also placed on minimizing mass, volume, and mechanical complexity.

Invention Description

Researchers at Arizona State University have developed a rover for non-Earth locomotion featuring a concentric pontoon drivetrain with motors inside four spinning Archimedes screws. These screws act as grousers, creating extra traction for propulsion. Rotating the screws in the same direction delivers highly efficient wheeled mobility, while the counter-rotating mode activates screw-driven mobility with high drawbar force. The result is a multi-modal vehicle capable of full planar movement which uses three fewer actuators than the current state-of-the-art lunar excavation robot. Steering is achieved by modulating relative speeds of the wheels. For excavation, a 1-DOF actuator lowers an excavation ramp, allowing material to be collected passively by skimming the ramp against the ground surface using the high-torque counter-rotating mode. The channeled ramp would feed regolith up into the craft body, where the material would then fall into a removable collection bin.

Potential Applications

- Excavation on dusty, off-Earth, regolith-dominated surfaces
- Exploration, sampling, and mining of moons and asteroids

Benefits and Advantages

- Internally driven pontoons: More efficient torque transfer, higher sealability from dust, and fewer points of failure than externally driven counterparts
- Robust, 1-DOF excavation system allows rapid collection not featured in competitors like the Regolith Advanced Surface Systems Operations Robot (RASSOR) Excavator

Research Homepage of Professor Hamidreza Marvi