AIRWHEEL: Auxiliary Inflatable Wheels for Lunar Rovers

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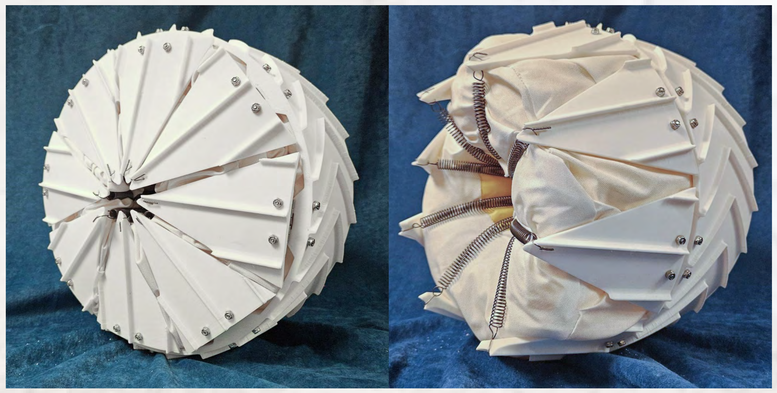
Project Vision

AIRWHEEL aims to design an auxiliary **inflatable** wheel to permit self-extraction of rovers from soft terrain. AIRWHEEL combines the best features of rigid and inflatable wheel designs into a single package, and has been tested in a linear test rig, on a small-scale rover (~30 cm dia. wheels) , and in a vacuum chamber.

The AIRWHEEL concept packs a **self-stowing inflatable** wheel into the center of a rigid wheel. This packing concept allows the rover to traverse rough terrain via the rigid wheel, with no risk of puncture damage to the inflatable. Should the vehicle become stuck in loose regolith, an inflation is commanded to deploy the inflatable bladder and grousers. Once the vehicle has extracted itself, a deflation is commanded to automatically stow and pack the inflatable back in the wheel.

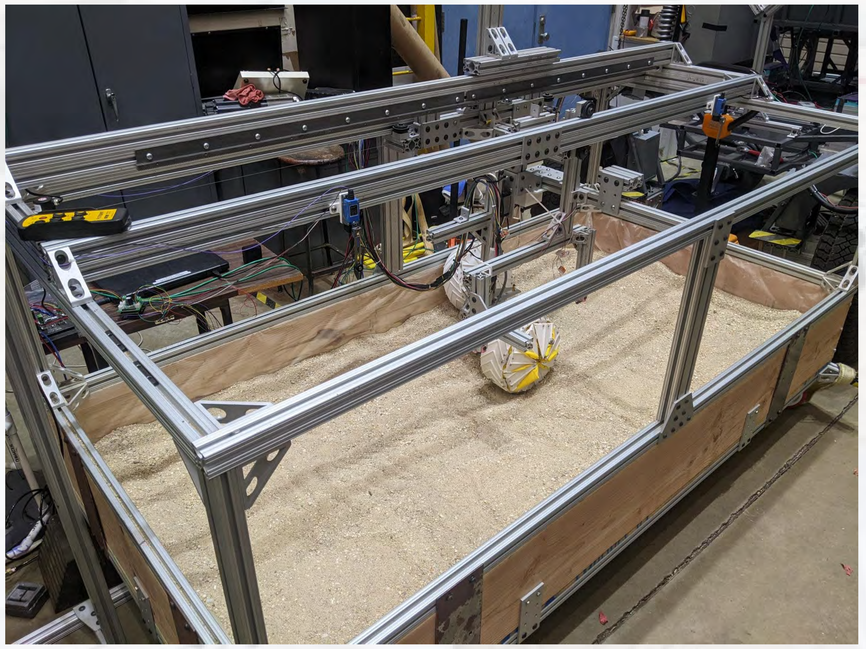
Wheel Design



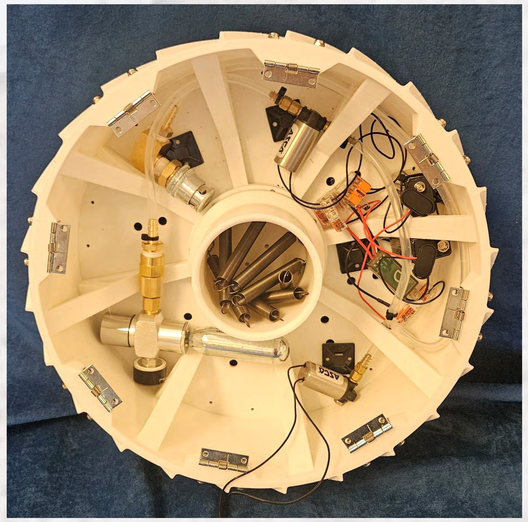
The wheel design has several key features that capitalize on the strengths of the inflatable system, while not comprising the benefits of a rigid wheel

- **Independent petal deployment** capitalizes on the inflatables ability to conform to soil, increasing the wheel contact patch, benefiting the wheel's tractive force
- These triangular petals **protect the softgoods** inside the wheel when stowed, and serve as the mounting points for the sprints that provide the **passive deflation capability**
- The triangular grouser petals also provide a surface to mount grousers to, eliminating the design challenge of affixing rigid grousers to an inflatable, which could easily bend under soil contact loads
- An internal mounting wall **minimizes soil ingress** and provides an internal component mounting system, and interfaces the wheel to the traction motor assembly
- The polyurethane-coated nylon pressure bladder is covered with a 500 Denier Cordura fabric for abrasion protection while deployed

Testing & Evaluation



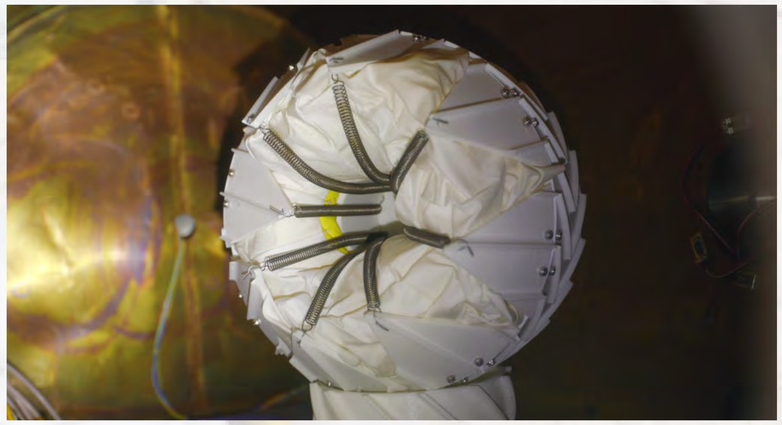
Weight on Test Rig Wheel (N)	Equivalent Lunar 4-Wheel Rover Mass (kg)	Equivalent Lunar 6-Wheel Rover Mass (kg)	Equivalent Martian 4-Wheel Rover Mass (kg)	Equivalent Martian 6-Wheel Rover Mass (kg)
91	225	337	98	146
122	302	452	131	196
158	389	584	169	254



Self-contained inflation unit: CO2 cartridge and regulator supply inflation gas to the pressure bladder. A pair of gas solenoids and wireless receivers control gas flow in/out of the pressure bladder to affect inflation/deflation. CO2 was chosen for the Earth test unit due to its storability and safety. A flight system will have to use a different gas.

Path to Flight

AIRWHEEL has been tested in an SSL **vacuum chamber** down to about 5 Torr and was shown to **deploy successfully in vacuum**. The retraction method, while slower in vacuum, does still **smoothly retract**. The wheel returns to a drive-able state within a few minutes and can finish to retract while driving.



Mission Adaptability

- **AIRWHEEL** is a self-contained unit that can be integrated into other rover systems with relative ease. Its pressure bladder and grouser designs allow for a **quick integration and de-integration** of the system whether it be for first time use or for maintenance
- The **independence** of this system requires no major modification to the traction motor system
- The **passive retraction method** uses no power, saving on mass and power requirements, and reduces system complexity