Lunar Rescue Concept for Incapacitated EVA Crew

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Abstract

In previous NASA lunar missions, no device existed to rescue astronauts in emergencies during extravehicular activities (EVA), making it impossible to retrieve an incapacitated crew member (ICM) stranded far from the lander. With the upcoming Artemis III mission, NASA is making the safety and survivability of astronauts in all aspects their first priority.

Design Goals

Objectives
- Minimal mass
- Minimal volume
- Minimal strength demands
- Minimal power use
- Portable
- Accommodates for limited dexterity
- Ease of deployment

Constraints
- Support ≤ 755lb
- Operable within 55K ~ 238K
- Operable on up to 20° inclines
- Tolerant to dust PM0.02 ~ PM10
- Usable for ≥ 1 hour

Order of Operations

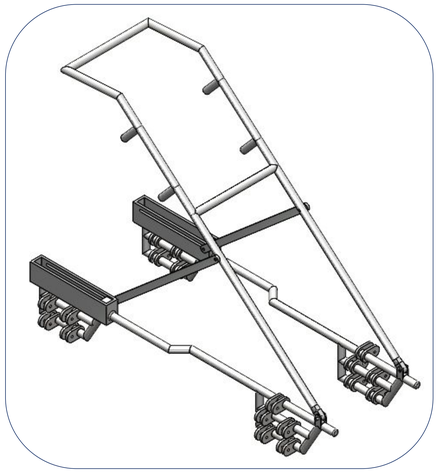
1) Move the ICM into a safe position.
2) Unclip tripod from platform, deploy above ICM.
3) Lower the winch, secure the ICM's attachment points (APs) on the winch.
4) Crank the winch to lift the ICM until they are sufficiently suspended above the ground.
5) Drive the platform under the ICM.
6) Lower the ICM so that their life-support system fits into the designated cavity on the platform.
7) Secure all of the ICM's APs on the platform and unhook them from the winch.
8) Wind the winch back, fold the tripod and clip back on the platform.
9) Adjust platform to a desirable height and begin trip back to homebase.

TSGC Design Challenge

Design a device to efficiently **rescue an ICM** while minimizing mass, volume, and power constraints.

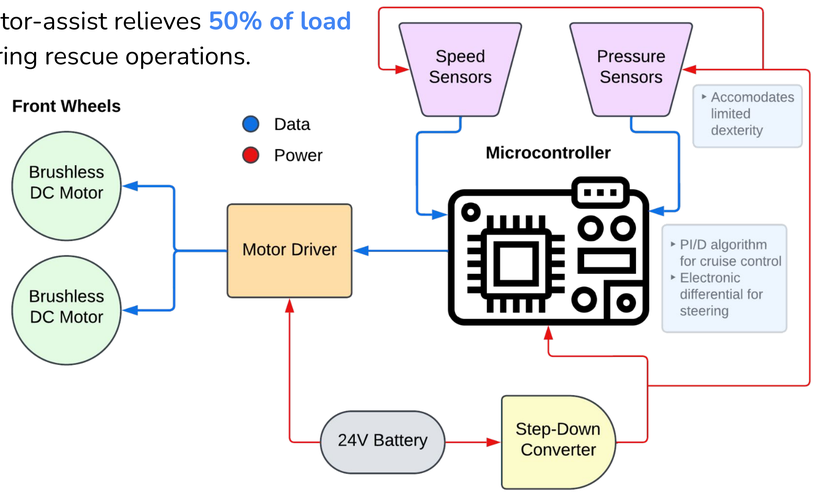
Platform Model

- **Sparse frame** minimizes mass and volume.
- **Transverse beam** reinforces the crew member's life support system.
- **Adjustable height**:
  - improves ergonomics for variable-height astronauts
  - improves stability on inclined surfaces.

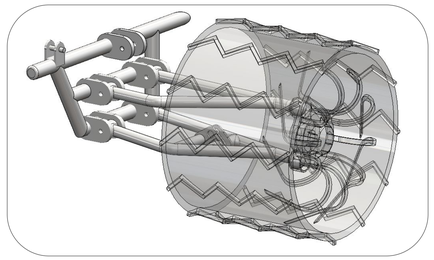


Motor-Assist System

Motor-assist relieves **50% of load** during rescue operations.

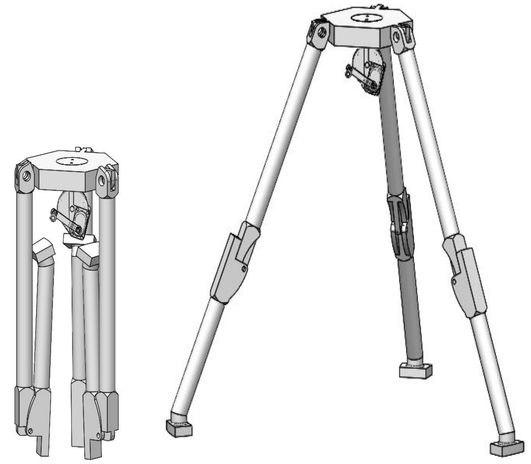


Wheel Design



- Wheel design imitates the **Curiosity rover**.
- **Zigzag treads** allow better traction on lunar terrain.

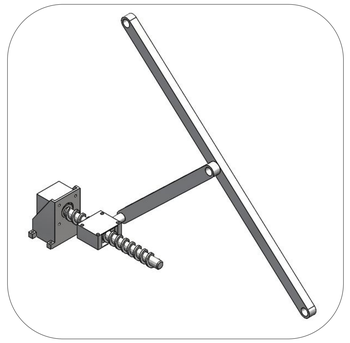
Tripod Model



- **Manual winch** allows ICM to be safely lifted.
- **Foldable legs** promote ease of storage and minimize volume.

Platform Hinge

Scott-Russell linkages convert linear motion of the lead screw collar into angular motion that raises and lowers the platform.



Next Steps

- **Testing + analysis for tripod and platform:** Design load, thermal, and durability tests for tripod, platform, and electrical system.
- **Wheelbase**: Finalize material selection, refine CAD design, and integrate with suspension for testing.
- **Motor-assist system:** Build higher-fidelity prototypes with a more defined control system and braking.
- **Thermal management system:** To manage heat dissipation from motors and extreme cold from the lunar environment.
- **Platform hinge**: Complete hinge durability tests and optimize locking mechanisms.

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