FY24 Strategic Initiatives Research and Technology Development (SRTD)

Steep terrain mobility for Mars and the Moon

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Strategic Focus Area: Lunar Science/ Moon and Mars Extreme Cold, Steep Terrain Rover **| Strategic Initiative Leader:** John D Baker

Objectives:

- Develop and demonstrate to TRL 4 a low-cost, flight-relevant surface mobility vehicle capable of traversing steep slopes up to 30º
- Develop mobility strategies for the exploration of craters on the Moon and at mid- and high latitudes on Martian terrain
- Enable access to new locations/sites of interest not previously accessible with current mobility systems
- Increase the safety margin when driving over the most extreme of these terrains
- Provide a platform for use in the development of autonomy capabilities by other Endurance-mission related SRTD tasks

Background:

- JPL's rocker-bogey (R-B) planetary rover design was developed more than 30 years ago; R-B rovers are limited to traverse slopes <15º on loose soils
- New surface mobility technologies and active suspension systems have been shown to improve mobility performance over passive R-B systems

Approach and Results:

- Developed ERNEST - Exploration Rover for Navigating Extreme Sloped Terrain (Figure 1 & 2)
- ERNEST is scaled to be one-half the size of the Endurance mission rover
- Demonstrated meeting the following performance metrics with ERNEST:
  - 30-degree slope traversals on lunar analogue regolith
  - Equivalent or fewer number of actuators compared with existing Mars rovers
  - Traverse over positive (boulders) and negative (craters) obstacles up to a wheel radius in size
  - Drive at speeds up to 1 km/hour

Significance/Benefits to JPL and NASA:

- New surface mobility vehicle design has excellent performance on steep slopes up to 35º over loose, weak granular material (Figure 3)
- Has minimal number of degrees of freedom
- Able to extricate itself from embedded situations in weak soils
- Able to climb over wheel-height obstacle (Figure 4)
- Developed a surface mobility vehicle with characteristics of the Endurance mission rover
- ERNEST will serve as the platform for development and demonstration of long-range mobility for the Endurance mission

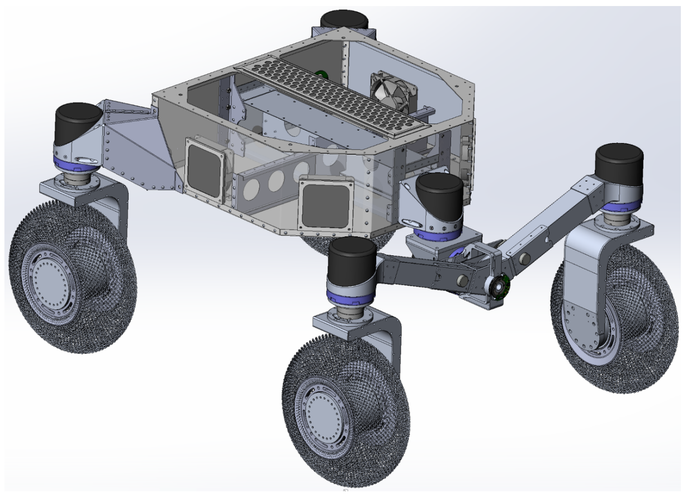

Figure 1. Design of ERNEST with an active gimbal suspension for advanced mobility capabilities.

Figure 2. ERNEST on its first drive in the mini-Yard next to JPL's building 198..

Figure 3. ERNEST climbing a 35º slope using its active gimbal suspension.

Figure 4. ERNEST climbing a wheel-height step obstacle using its active gimbal suspension.

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Publications:

1. Bouton, A, Reid, W., Brown, T., Daca, A., Sabzehi, M., Nayar, H., "A comparative study of alternative rover configurations and mobility modes for planetary exploration," IEEE Aerospace Conf, Big Sky, MT, 2023
2. Nguyen, M., Bouton, A, Nayar, A., Suntup, M., Brown, T., Reid, W., "Trajectory Optimization Methods for Energy Efficient Gait Transitions on Multi-Modal Robots," submitted to IEEE Aerospace Conf, Big Sky, MT, 2024

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