ROB-GY 7863 Project 1 Proposal

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Lunar Space Rover Terrain Navigation Simulation

1 Mission:

The mission focuses on developing a simulated lunar rover [1][2] capable of navigating uneven and unpredictable terrain on the Moon. The rover must maintain stability, avoid obstacles, and adapt to variable slopes while operating under low-gravity conditions. The motivation is to study rover-terrain interaction in a controlled simulation environment, providing insights that can inform real-world lunar exploration missions.

2 Expected Contribution to Simulation:

This project will introduce dynamical modeling for rover simulation:

1. Compliant suspension to capture chassis tilt and wheel load distribution.
2. Slope- and terrain-dependent wheel friction to improve traction prediction.
3. Low-gravity adaptation to realistically simulate Moon conditions. The simulation will integrate classical control and vision-based feedback, allowing the rover to navigate autonomously using sensors without machine learning.

3 Expected Numerical Experiments:

Three key experiments will validate the simulation and demonstrate the contribution of the dynamical modeling:

1. Slope Navigation Test: Evaluate rover stability and wheel slip on slopes ranging from 0° to 30°.
2. Obstacle Avoidance Test: Measure the rover's ability to navigate around randomly placed rocks and craters using vision-based control.
3. Low-Gravity Adaptation Test: Compare rover performance under Earth and Moon gravity to validate the low-gravity dynamics model.

References

[1] Karl Iagnemma and Steven Dubowsky. *Mobile robots in rough terrain: Estimation, motion planning, and control with application to planetary rovers*, volume 12. Springer Science & Business Media, 2004.

[2] Mark W Spong, Seth Hutchinson, and M Vidyasagar. Robot modeling and control. *John Wiley &amp*, 2020.