Rover Modelling, Analysis and Dynamic Simulation for Planetary Exploration

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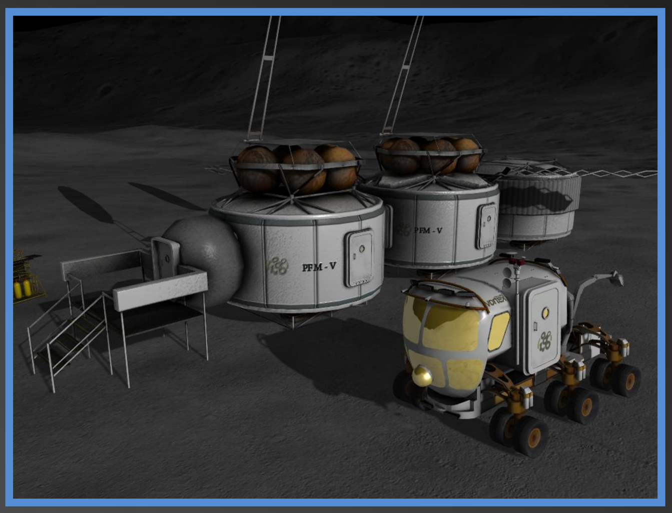
Overview

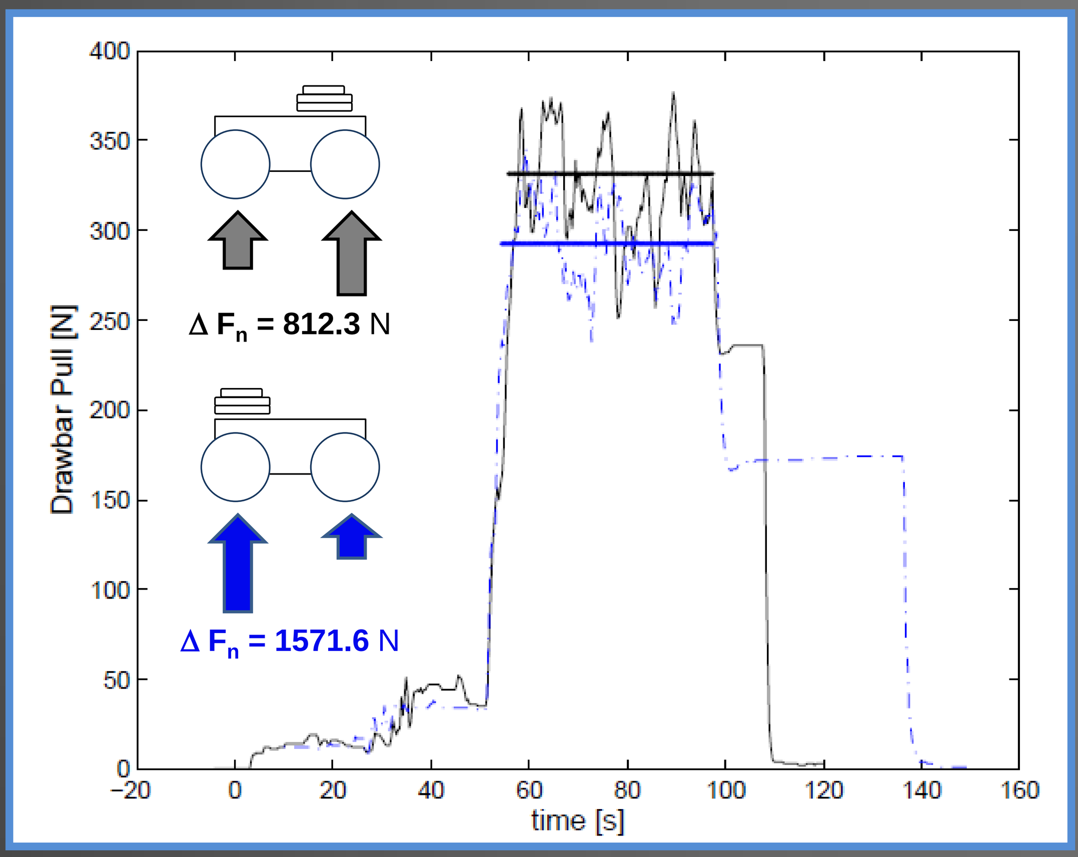
- Investigation of various aspects of surface mobility, which is critical for lunar missions and planetary exploration
- Development of advanced methods, models, and tools to assist in the design, control, and operation of mobile robotic systems
- Provide information to the engineer for the solution of typical design, control, and operation tasks for mobile robots



Vehicle-Terrain Interaction Modelling for Analysis and Performance Evaluation

- Aims to provide analysis and characterization of rover mobility and vehicle – terrain interaction
- Captures the effect of changes of vehicle design parameters on and vehicle – terrain behaviour
- Gives parametric performance indicators that represent the effect of system parameters

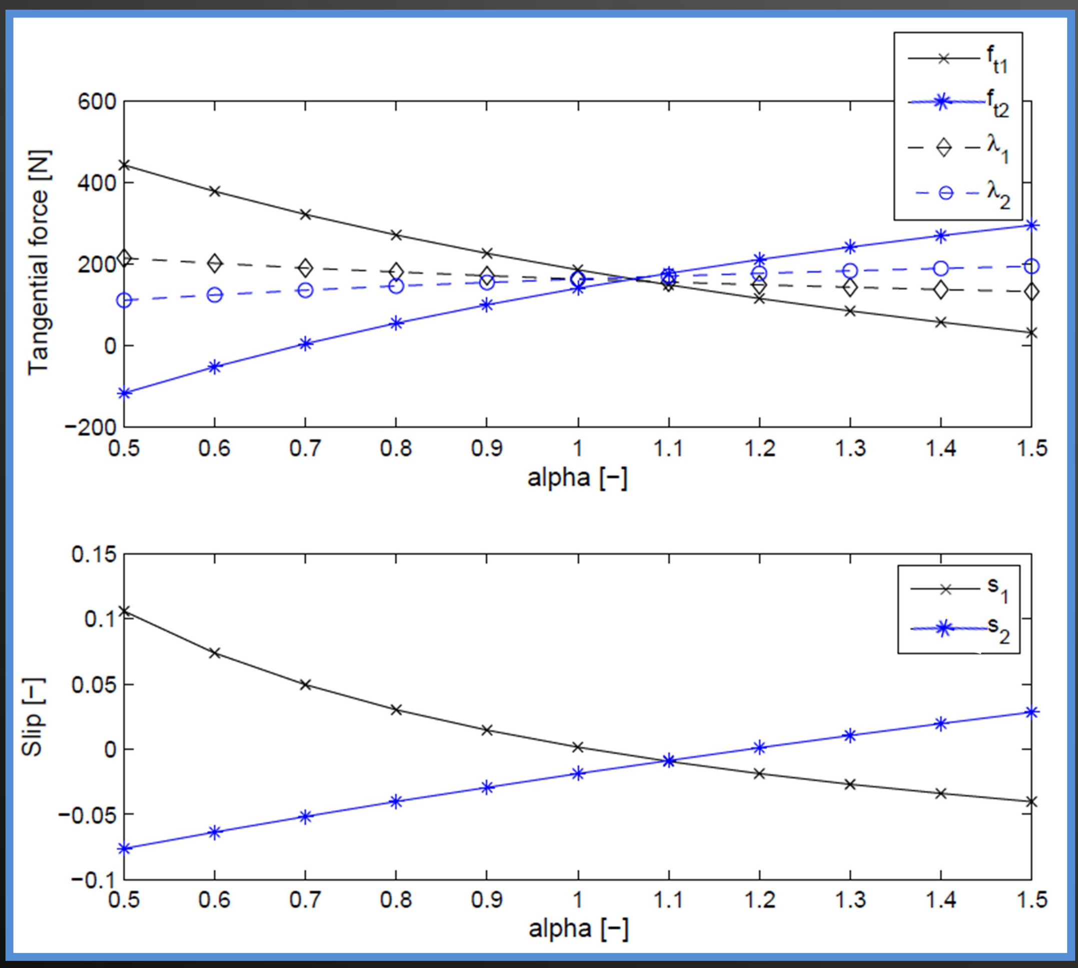
Example 1: Change of Centre of Mass



Example 2: Change of Wheel Torque Distribution

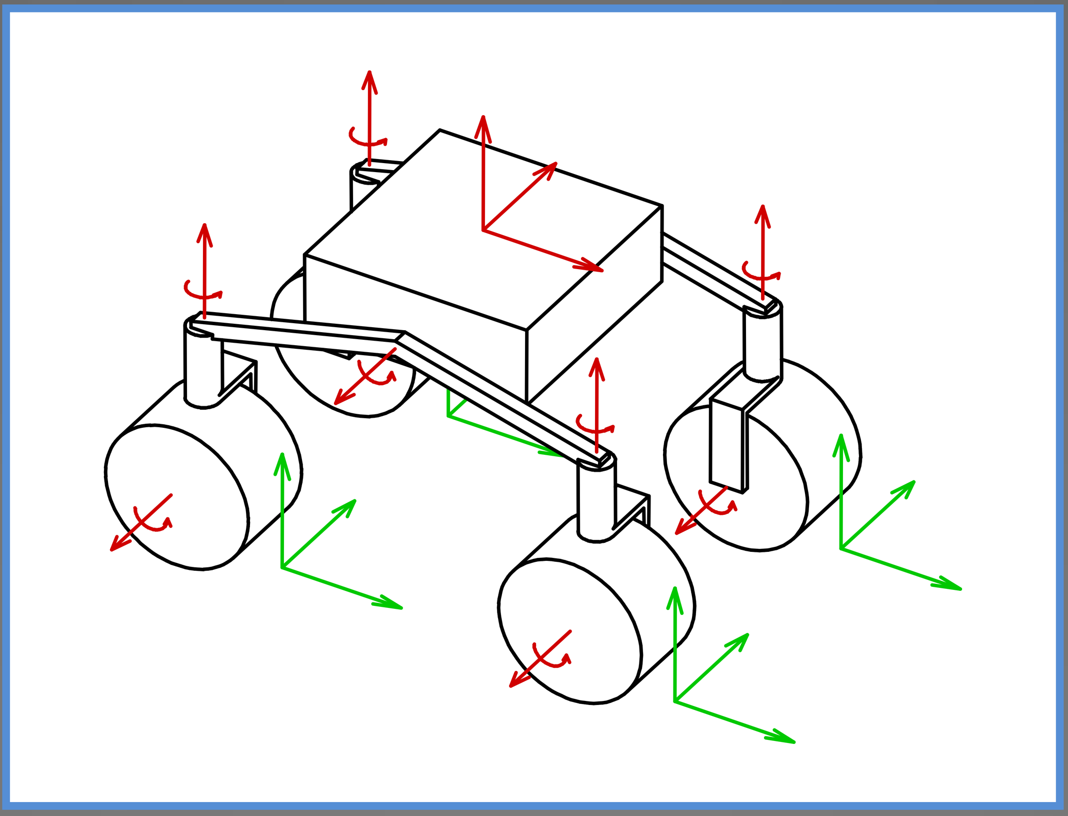
Tangential force (λ) ← Complementary → Slip (i_s)

- Front wheel torque $\tau_1 = \frac{1}{1+\alpha}\tau$
- Rear wheel torque $\tau_2 = \frac{\alpha}{1+\alpha}\tau$



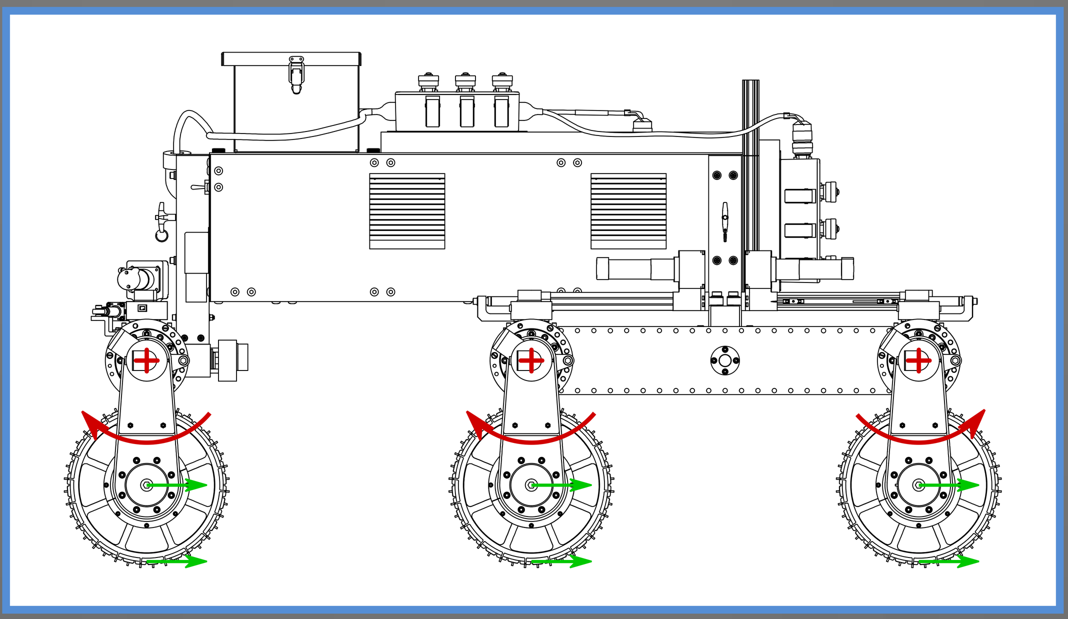
Operational Space Formulation

- Formulate rover equations in terms of key variables, which for rovers generally relate to motion of the wheels



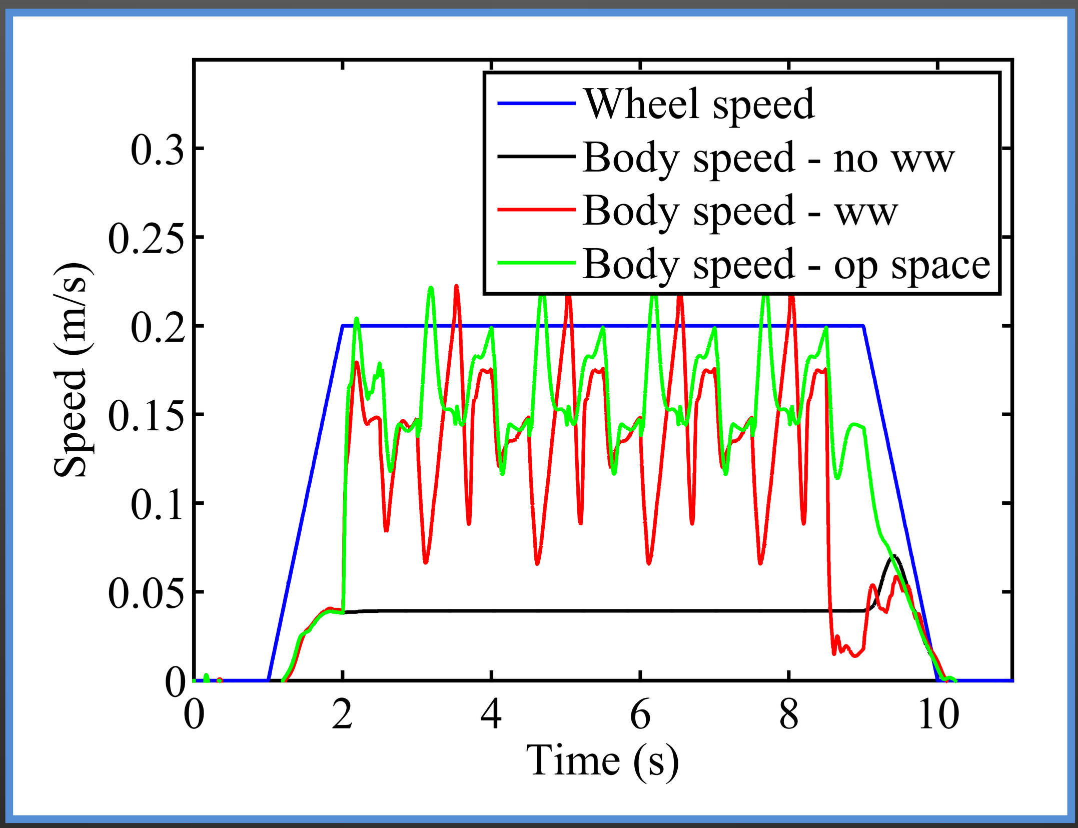
Wheel Walking Control of CBR

- Formulation to directly control wheel and wheel centre velocities, which simplifies wheel walking control



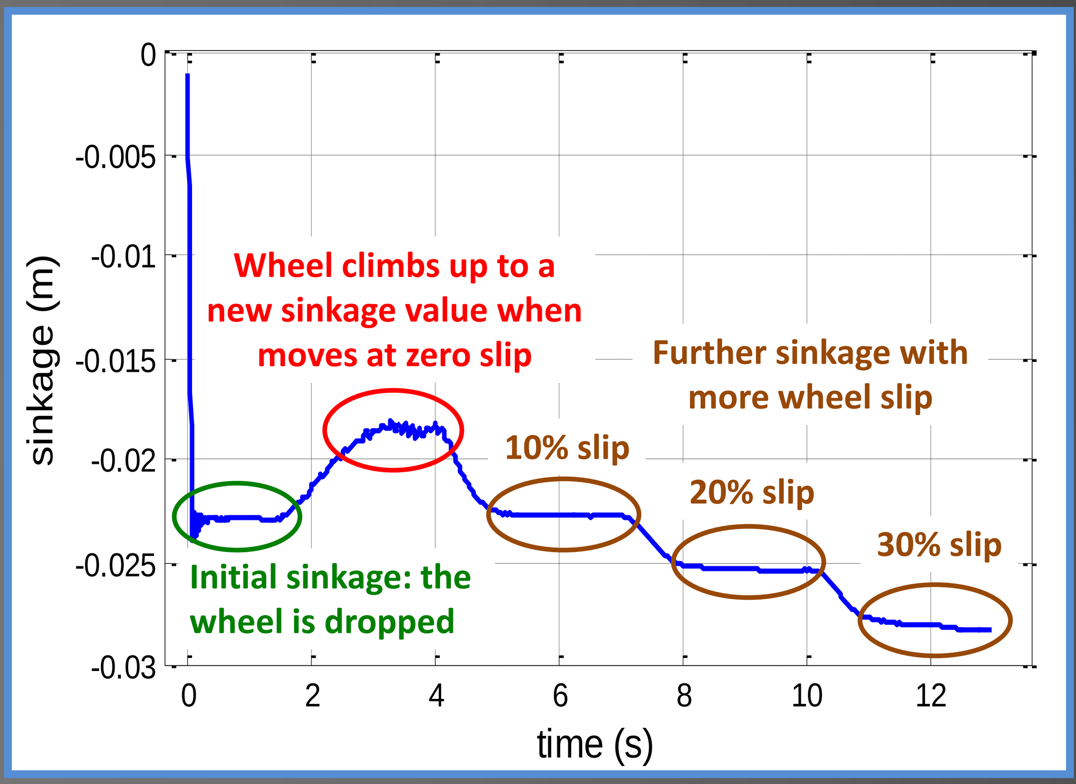
CBR Wheel Walking Simulation

- Significant slip when driving forward with no wheel walking (no ww)
- Improved traction with wheel walking and direct joint control (ww)
- Consistently less slip with operational space control of wheel walking (op space)

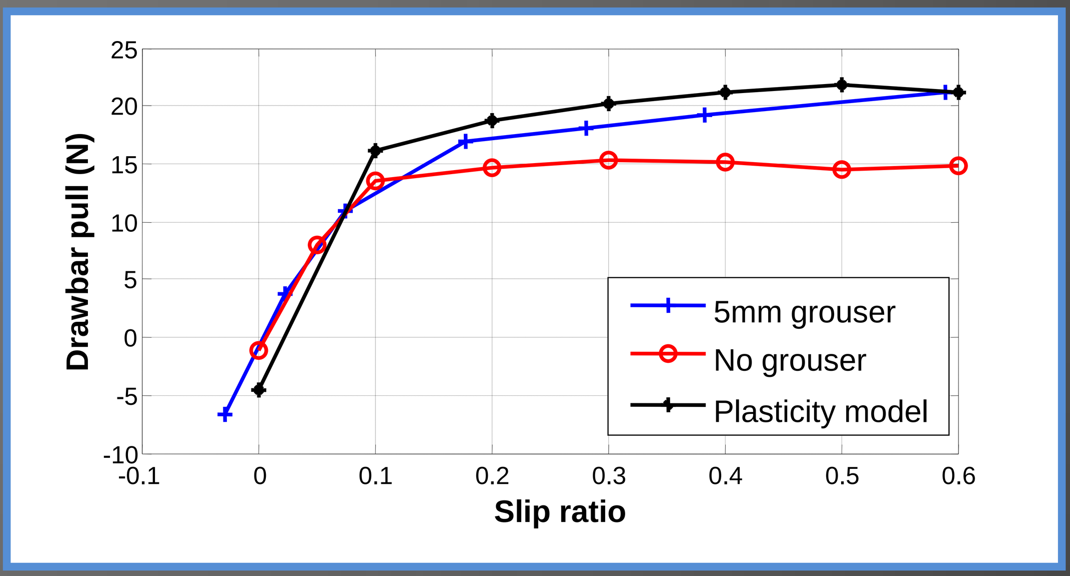


Novel Wheel-Soil Interaction Model Based on Plasticity Theory

- Appropriate for real-time applications
- Captures dynamic phenomena
- Addresses slip-sinkage effects
- Incorporates soil compaction and hardening (multipass)



Comparison to Experimental Results



High-fidelity Rover Simulation in Vortex

- Semi-empirical model with soil compaction and hardening