Modelling and Analysis Methods and Tools to Support Mobile Robotics Design and Control

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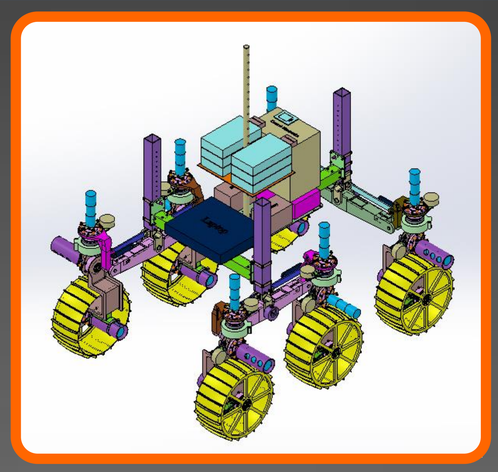
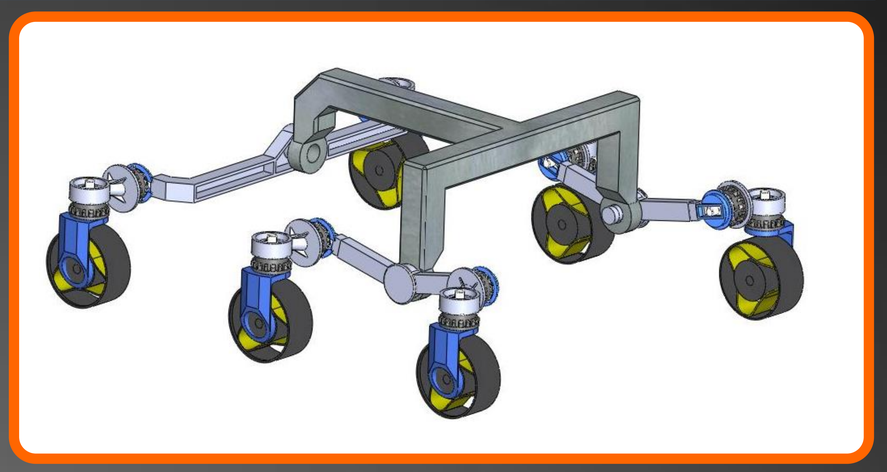
Objectives

- Quantify the effect of design and operation parameters on rover behaviour
- Develop tools and techniques for improving rover performance
- Develop dynamics model-based state estimation algorithms
- Experimentally study the effectiveness of the proposed methods

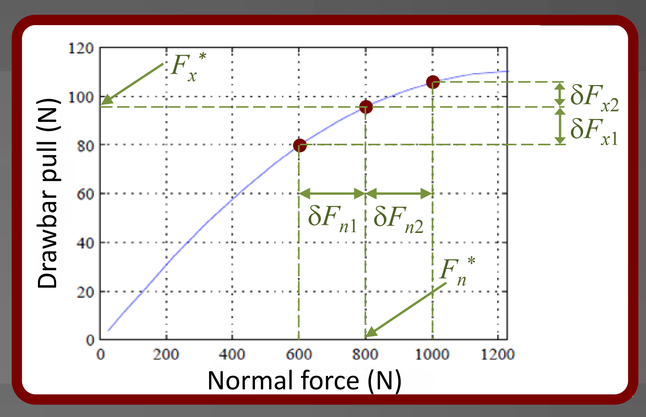


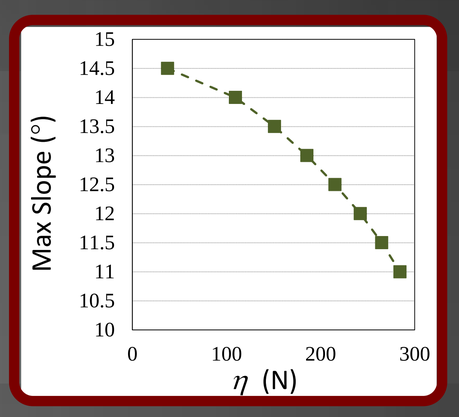


Effect of Normal Force Distribution on Mobility

- Uniform normal force distribution among wheels improves vehicle mobility
  - → Concept of normal force dispersion: η
- Reduced normal force dispersion helps the vehicle climb steeper slopes

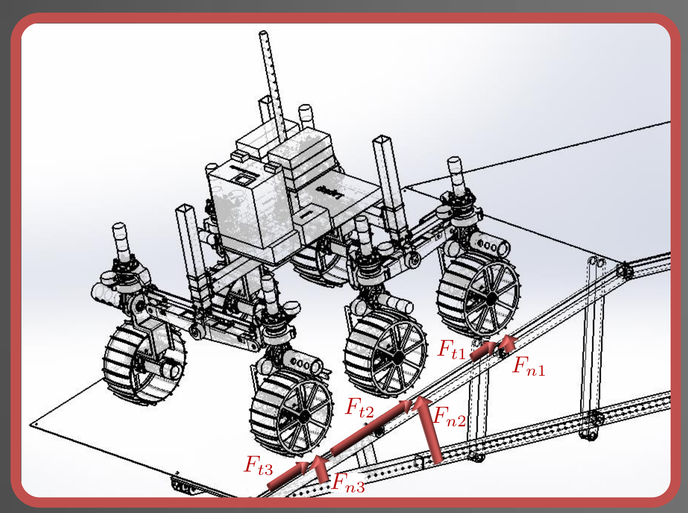
$$\eta\left(F_{n1},\ldots F_{np}\right)=\sqrt{\frac{1}{p}\sum_{i=1}^{p}\left(F_{ni}-\mu\right)^{2}}$$

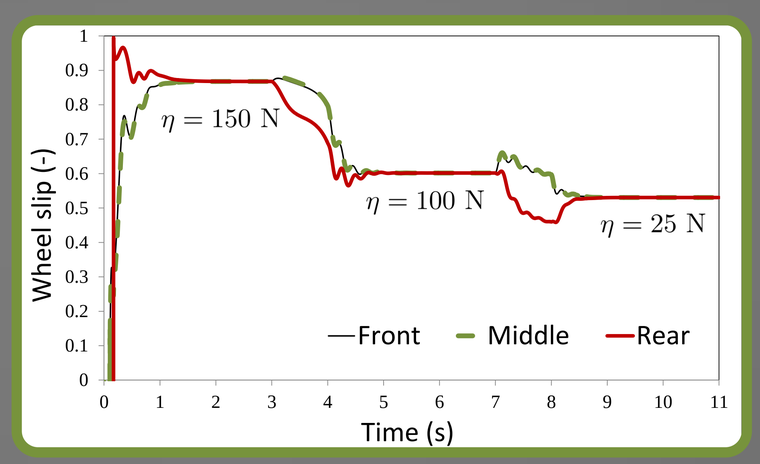


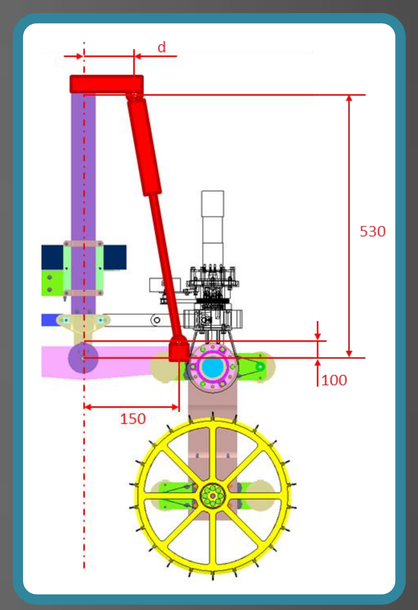


Introduction of Actuation to Improve Rover Performance

- Internal actuation can be used during slope climbing and obstacle negotiation
- Design of a set of experiments with RCP to validate the proposed strategy



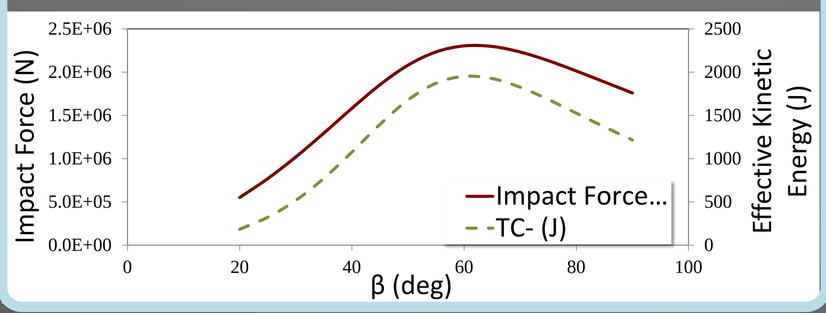




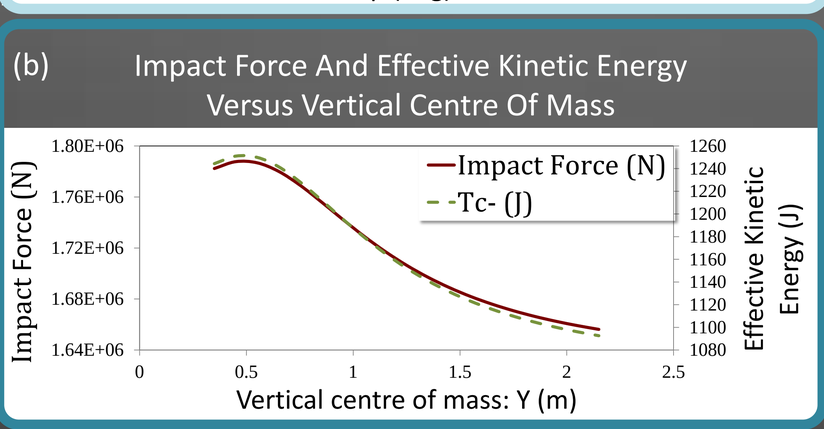
Study of Contact and Impact Forces

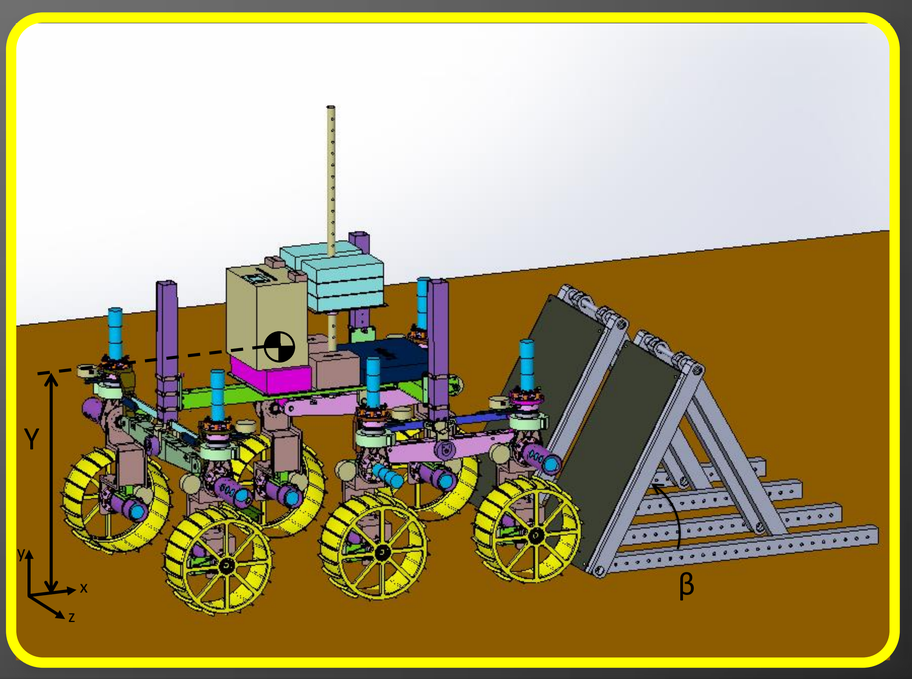
- Effective kinetic energy as indicator of intensity of contact
- Design of intelligent obstacles to study the normal contact force

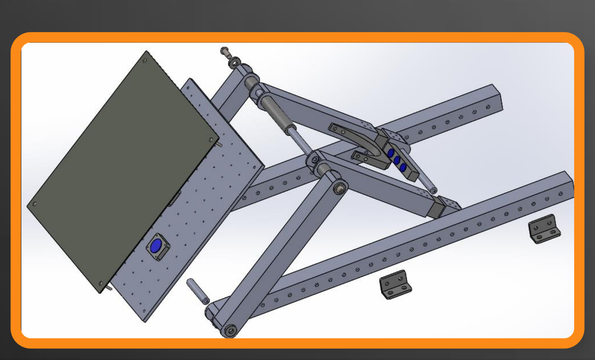
(a) Impact Force and Effective Kinetic Energy (Tc-) Versus Angle of Impact



(b) Impact Force And Effective Kinetic Energy Versus Vertical Centre Of Mass







Navigation and State Estimation

- Use of the dynamic model of the rover to reduce position estimation errors
- Readings from encoders and IMU's can be complemented with input from force-torque sensors

- B. Ghotbi, F. González, J. Kövecses and J. Angeles. Effect of Normal Force Dispersion on the Mobility of Wheeled Robots Operating on Soft Soil. Accepted in the *IEEE International Conference on Robotics and Automation ICRA 2014, Hong Kong, China, May 31 – June 7, 2014.*