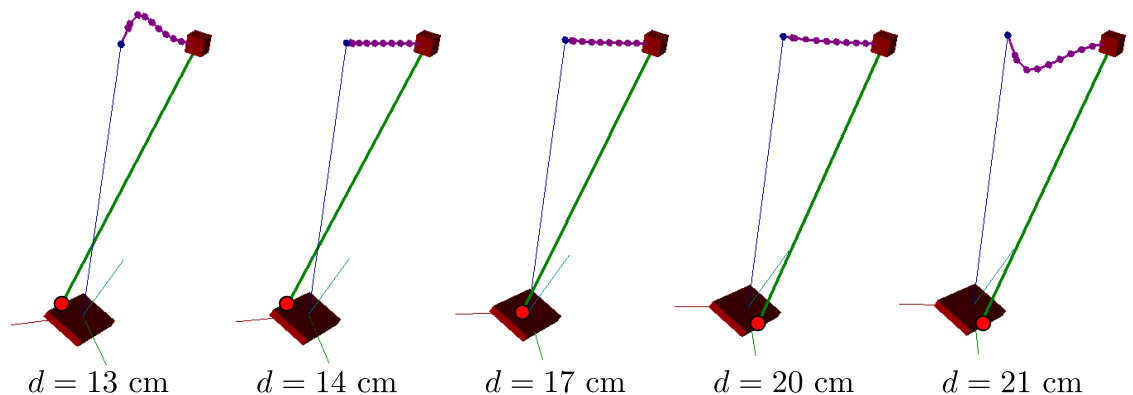


4 — Boundedness MPC in 3D

Caron & Mallein — Submitted to ICRA 2018

Contact stability

Polyhedral projection
of the Contact Wrench Cone
yields an **Analytical formula**



Model

Inverted Pendulum Model : $\ddot{\mathbf{c}} = \lambda(\mathbf{c} - \mathbf{r}) + \mathbf{g}$

Time-varying Divergent Component of Motion : $\dot{\omega}(t) = \omega(t)^2 - \lambda(t)$

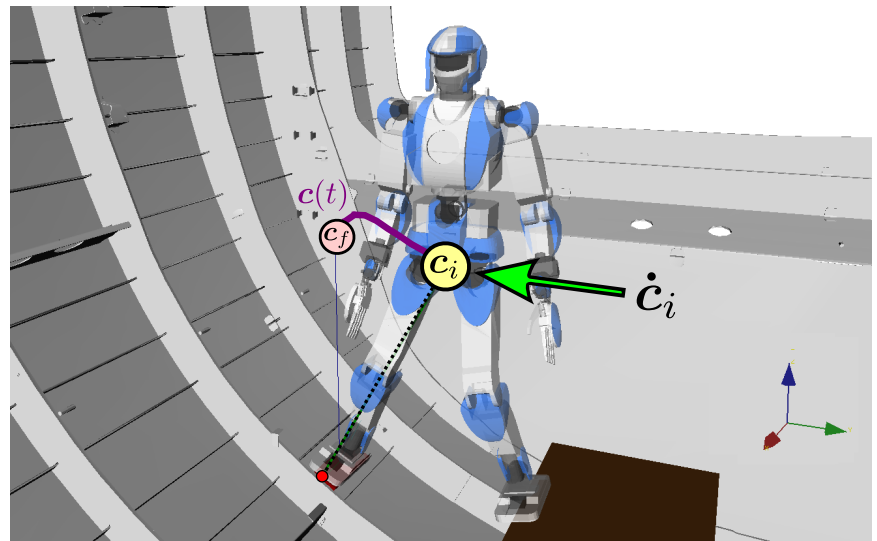
Switch to spatial variable : $s(t) = e^{-\Omega(t)}$

Boundedness condition

Satisfied by all non-diverging trajectories:

$$g \int_0^1 \frac{ds}{\omega(s)} = \dot{\bar{z}}(0) + \omega(0)\bar{z}(0)$$

$$\int_0^1 \mathbf{p}(s)(s\omega)' ds = \dot{\bar{\mathbf{c}}}(0) + \omega(0)\bar{\mathbf{c}}(0)$$



Novelty

Nonlinear optimization has only one optimum, solved very fast ($< 3 \text{ ms}$)



<https://github.com/stephane-caron/3d-balance/>