A Wrench-Sensitive Touchpad

Based on a Parallel Structure

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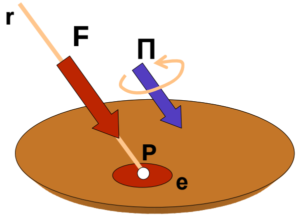
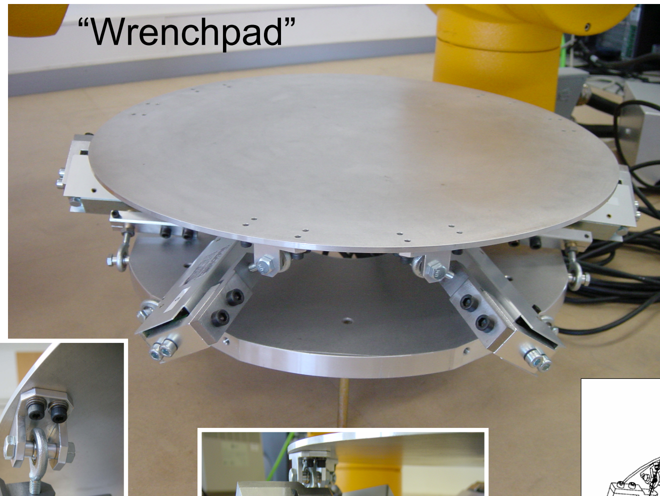
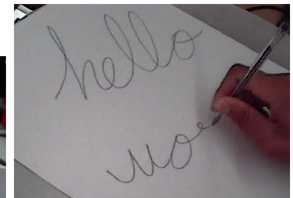
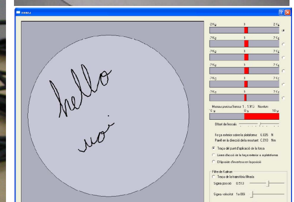
Output

Force **F**
Torque **Π**
Line of support **r**
Application point **P**
Uncertainty ellipse **e**









Technical specs.

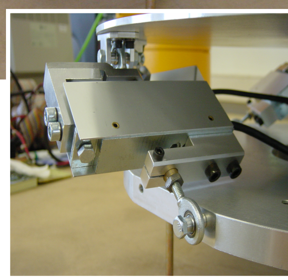
Global specs:

- Frequency: 20 Hz
- Max. force in the center: 30 N
- Max. force in the perimeter: 10 N
- Platform: weight=2Kg, ∅=434 mm

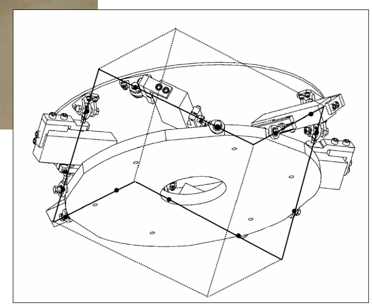
Leg specs:

- Load cell model: UTILCELL 105, 2 Kg
- Load cell precision: +/- 0.4 g
- Leg load range: [-2.4, 13.6] N

Leg joints (spherical)



Leg load sensors



Sensor geometry (from a cube)

Good distribution of leg forces

Force Jacobian

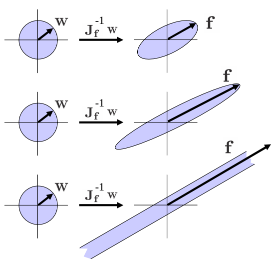
Space of leg forces $\mathbf{f}$ $\quad \mathbb{R}^6 \xrightarrow{\mathbf{J_f}} \mathbb{R}^6 \quad$ Space of platform wrenches $\mathbf{w}$

What happens in a singular design?

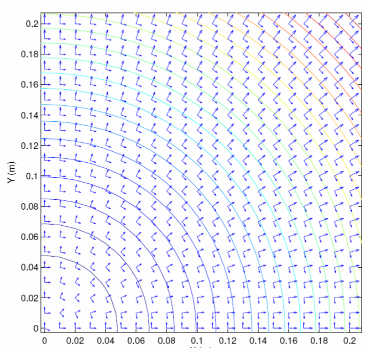
Far from a singularity — Our design

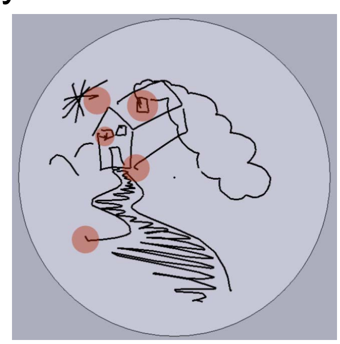
Near a singularity

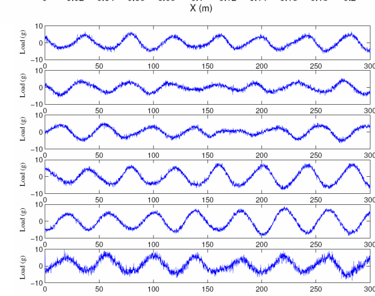
In a singularity

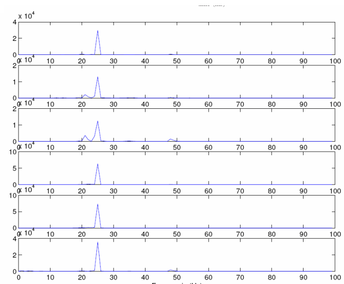


Static and dynamic errors



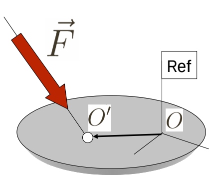






Computing the wrench line (simplest case)

If the wrench is a pure force (no pure torque acts on the platform) the first three components of the wrench give the **direction** of the line, the second three give a **point** on it:



$$\mathbf{w} = \begin{pmatrix} \vec{F} \\ \vec{M} \end{pmatrix}$$

$$\vec{M} = \overrightarrow{OO'} \times \vec{F}$$

$$\begin{bmatrix} M_1 \\ M_2 \\ M_3 \end{bmatrix} = \begin{pmatrix} 0 & F_3 & -F_2 \\ -F_3 & 0 & F_1 \\ F_2 & -F_1 & 0 \end{pmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

Poinsot's central axis theorem is used in the general case.

A tensegrity structure to reduce the errors