Midterm Presentation

The Quadrocopters

Technische Universität München

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Optimal control problem

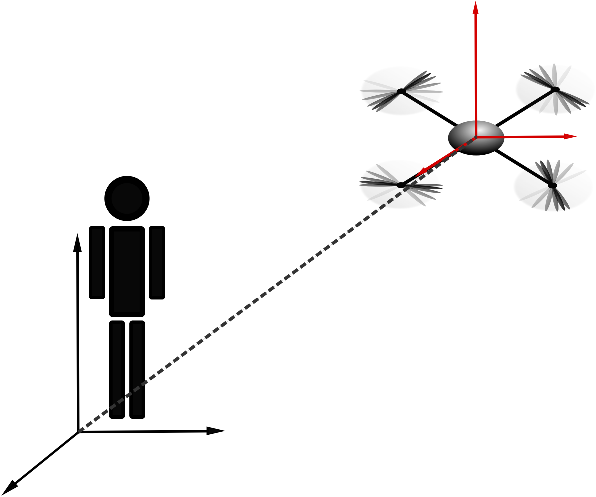
$$\min_{x,u} J(x,u) \qquad \dot{x} = f(x,u)$$

$$x : \text{state}$$

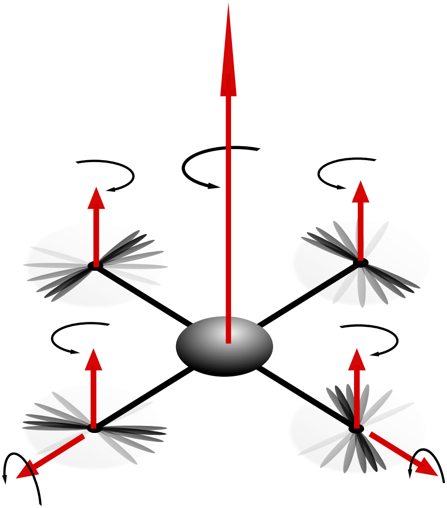
$$u : \text{control}$$

$\rightarrow$ Additional difficulty: realtime approach

Coordinate systems



Forces and Torques



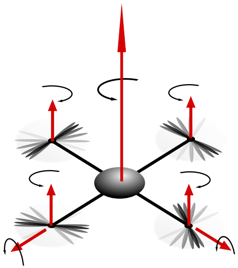
Newton-Euler Equations

Forces

$$F_{ext} = F_g + \sum_{i=1}^{4} F_i$$

Torques

$$\tau_{ext} = \sum_{i=1}^{4} \tau_i + (\tau_\phi + \tau_\theta)$$



Quaternions

$$q = a + \mathrm{i}b + \mathrm{j}c + \mathrm{k}d \qquad a, b, c, d \in \mathbb{R}$$

representing rotation $\Leftrightarrow \|q\| = 1$

Advantage $\rightarrow$ no singularities

Problem $\rightarrow \|q\| = 1$ additional constraint

Dynamics

Equations representing dynamics...

$$T(x,u) = M \cdot \begin{pmatrix} \dot{x}_8 \\ \vdots \\ \dot{x}_{13} \end{pmatrix} + \Theta(x)$$

...expressed as system of differential equations

$$\frac{\mathrm{d}}{\mathrm{d}t} \begin{pmatrix} x_1 \\ \vdots \\ x_7 \\ x_8 \\ \vdots \\ x_{13} \end{pmatrix} = \begin{pmatrix} \dot{x}_1 \\ \vdots \\ \dot{x}_7 \\ M^{-1}(T(x,u) - \Theta(x)) \end{pmatrix}$$

Prospect

Refinement of the model

$\rightarrow$ wind

$\rightarrow$ aerodynamical forces

[2] [1] [3]

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