Disclaimer

These slides are intended as presentation aids for the lecture. They contain information that would otherwise be to difficult or time-consuming to reproduce on the board. But they are incomplete, not self-explanatory, and are not always used in the order they appear in this presentation. As a result, these slides should not be used as a script for this course. I recommend you take notes during class, maybe on the slides themselves. It has been shown that taking notes improves learning success.

Reading for this set of slides

- Craig – Intro to Robotics (3rd Edition)
  - Chapter 10.8

Please note that this set of slides is intended as support for the lecture, not as a stand-alone script. If you want to study for this course, please use these slides in conjunction with the indicated chapters in the text books. The textbooks are available online or in the TUB library (many copies that can be checked out for the entire semester. There are also some aspects of the lectures that will not be covered in the text books but can still be part of the homework or exam. For those It is important that you attend class or ask somebody about what was covered in class.

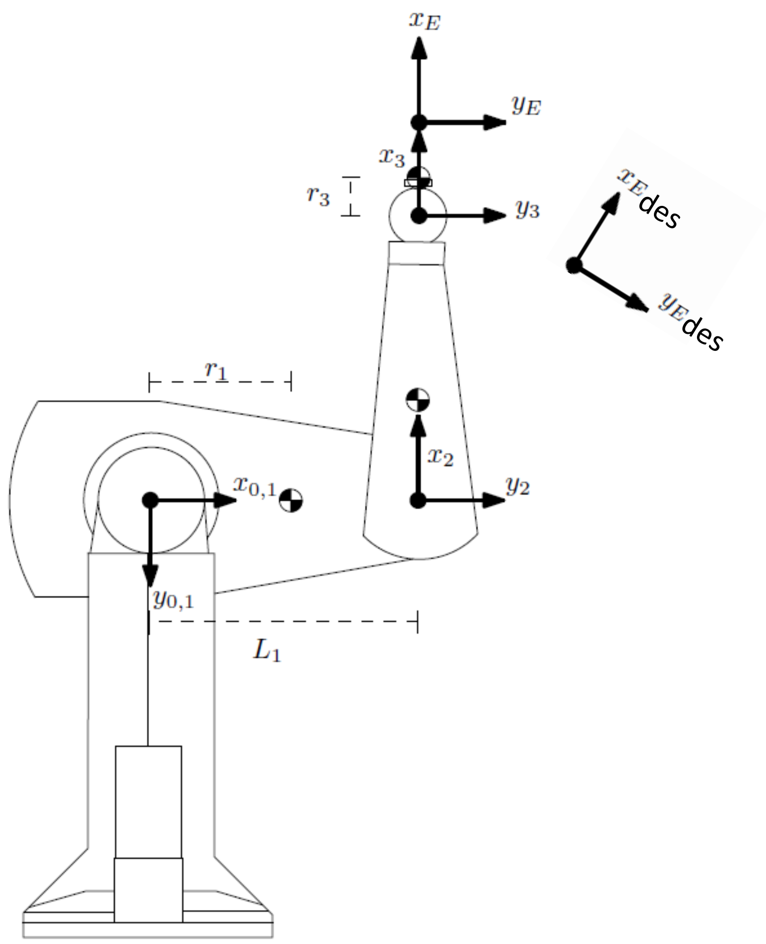
Robotics

First Steps in Operational Space Control

TU Berlin

Oliver Brock

Following a Trajectory With the End-Effector



See Tutorial on Trajectory Generation

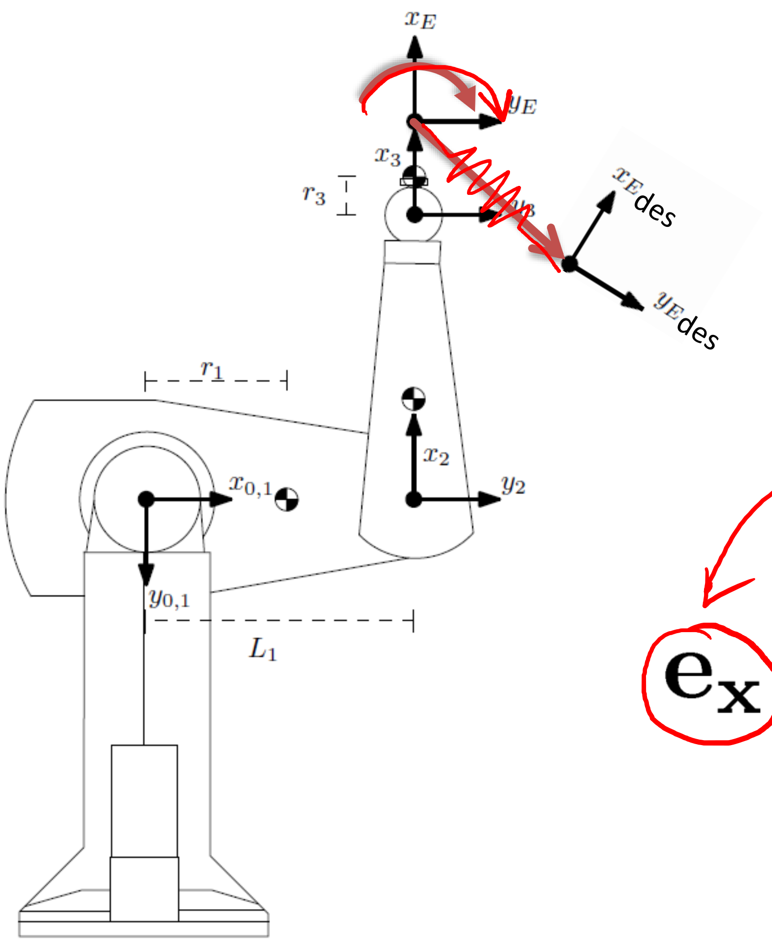
Resolved-Rate Motion Control

$$\dot{\mathbf{q}}^* = J(\mathbf{q})^{-1}\,\dot{\mathbf{x}}^*$$

$$\mathbf{q}^*_{t+1} = \mathbf{q}_t + \delta t\;\dot{\mathbf{q}}^*_t$$

The * indicates a desired quantity as opposed to a measured one

Control of the End-Effector



POSE T + R

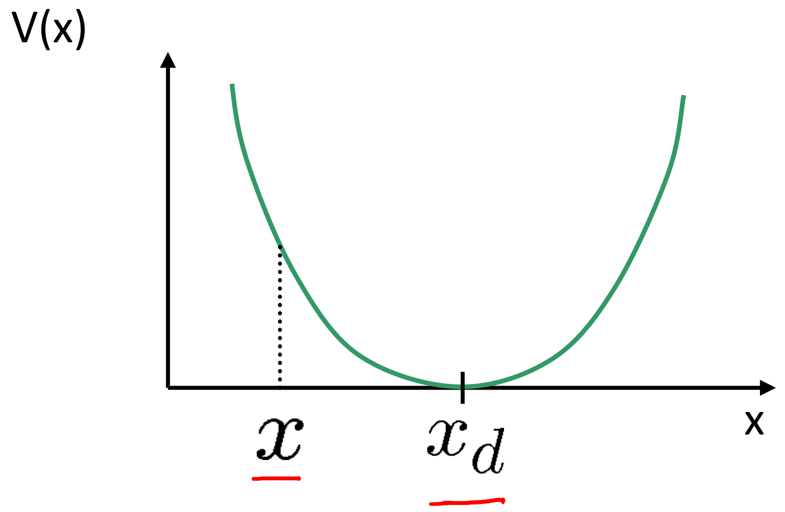
$$\mathbf{e_x} = \mathbf{x}_{\text{des}} - \mathbf{x}$$

P Control in Operational Space

Idea: apply force proportional to error

$$f = -\boxed{k_p}\mathbf{e}$$

position gain



$$V(\mathbf{x}) = \frac{1}{2}\mathbf{k}_p\mathbf{e}^2$$

$$\mathbf{F} = -\nabla V(\mathbf{x}) = -\frac{\partial V}{\partial \mathbf{x}}$$

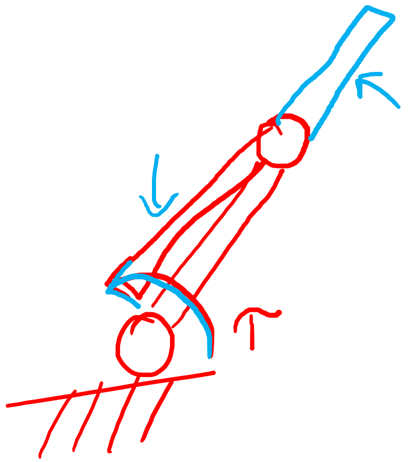
First Operational Space Control

INERTIAL PROPERTIES

$k(q)$

OPERATIONAL SPACE INERTIAL MATRIX $\Delta(q)$

$$\tau = \underline{\underline{\mathbf{k}}}\, J^T \mathbf{F} + G(\mathbf{q})$$



$F = m \cdot a$