Rates of Convergence

Feedback Control

Recall the control problem

Determine the appropriate input that will cause the error between the desired state and the actual state of a dynamical system to eventually reach 0.

$$e(t) = x^{des}(t) - x(t) \to 0 \text{ as } t \to \infty$$

Rates of Convergence

How fast do we want this error to go to 0?

- The error *exponentially converges* to 0 if there exists constants α and β and time t_0 , such that for all $t \geq t_0$:

$$\|e(t)\| \leq \alpha e^{-\beta t}$$

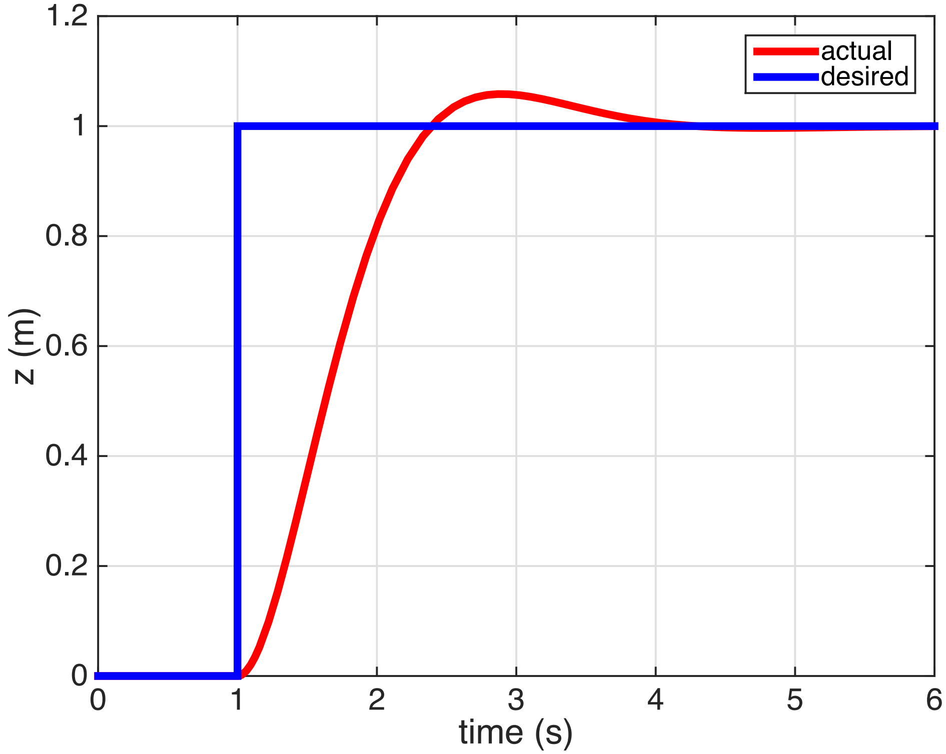
Feedback Control

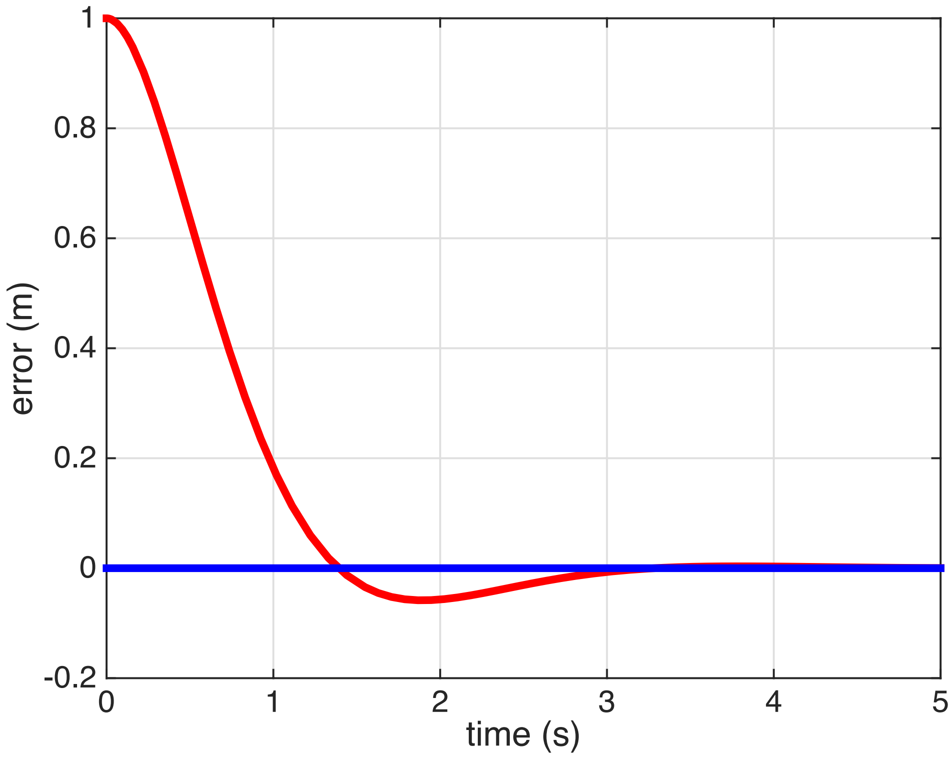
Here we will accomplish this using a PD (or PID) controller.

$$u(t) = \ddot{x}^{\mathrm{des}}(t) + K_v \dot{e}(t) + K_p e(t)$$

Consider the controllers we used before to control the height of a quadrotor.

Example 1: PD Controller





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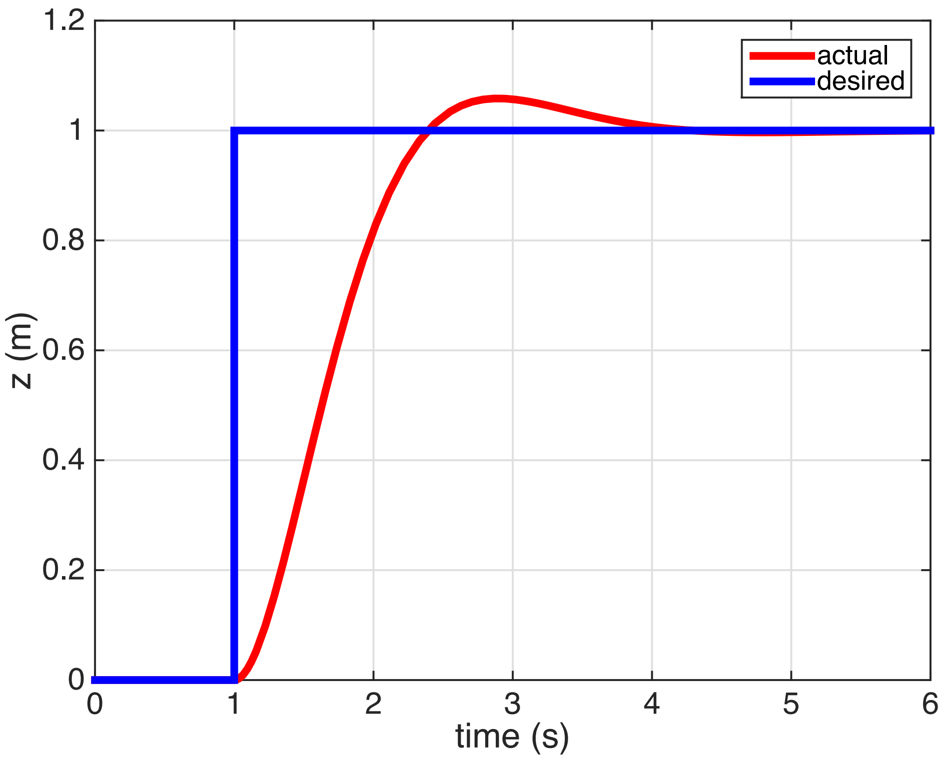
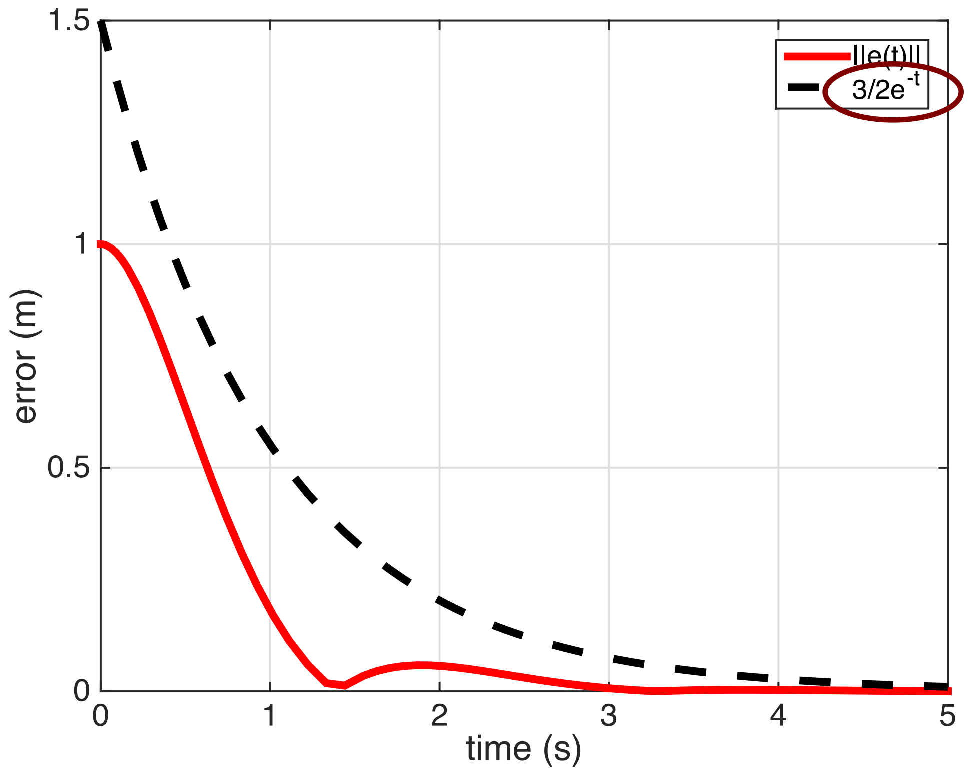
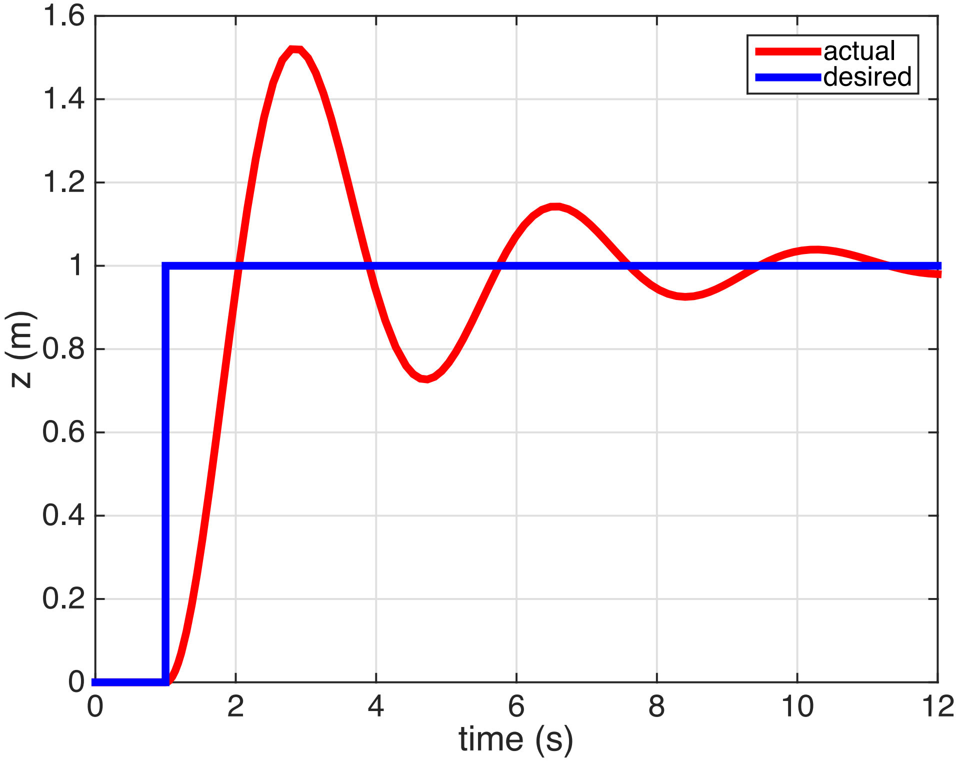
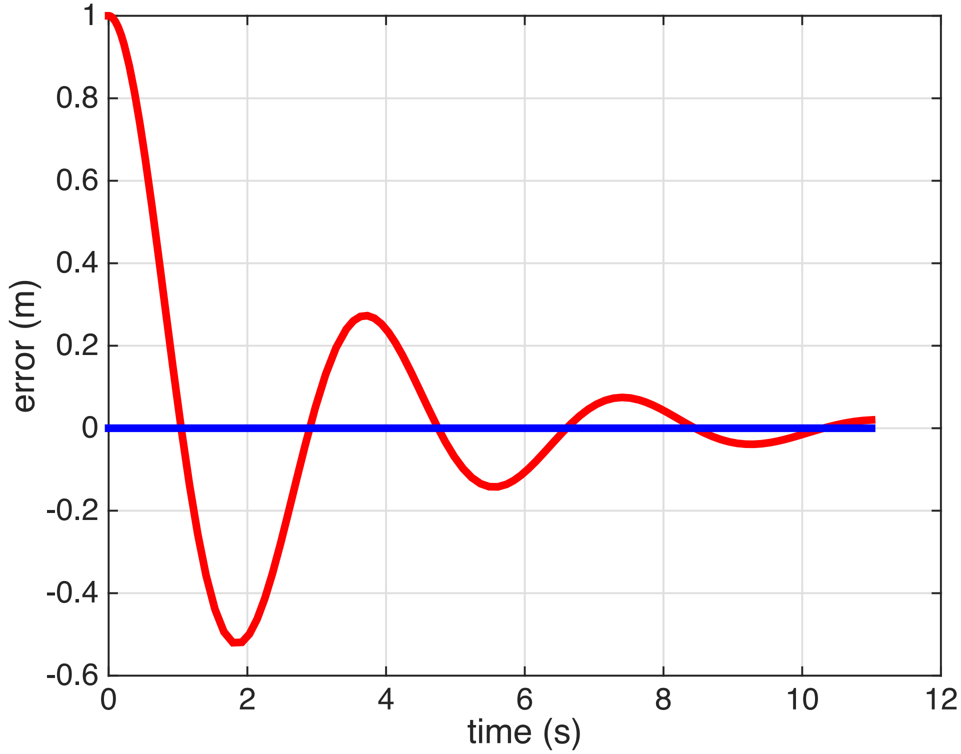
Example 1: PD Controller





Example 2: High K_p





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Example 2: High K_p