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Concept Review
PID Control

Why PID Control?

When implementing advanced controllers, a grasp of the basic characteristics of the plant model is often required. Model-based controllers are suited for industrial applications in the presence of noise, disturbances, etc., but require a thorough analysis and model to begin with. In contrast, PID controllers are very robust as they generally combine the advantages of all three types of compensation terms – proportional, integral, and derivative.

This combination is straight-forward to implement given an error term, requires fundamental knowledge of the compensation terms, and has extensive support in literature on common manual and automatic tuning methods. These make PID controllers very popular amongst control engineers.

Background

An important component of any robotics platform is the concept of controlling states to reach a desired value. A common control technique is called a **Proportional-Integral-Derivative** (**PID**) controller. This control strategy compares the current state of a system to the desired value and calculates an error term $e(t)$. As this error term changes with time a PID controller can be used to generate command inputs to actuators in any platform.

PID Control

Consider the following terms:

- Measured state of a system y_m
- Desired sate y_d

The equation for the error term can be written as:

$$e(t) = y_d(t) - y_m(t)$$

$$E(s) = Y_d(s) - Y_m(s)$$

The block diagram for a PID control loop can be visualized in Figure 1.

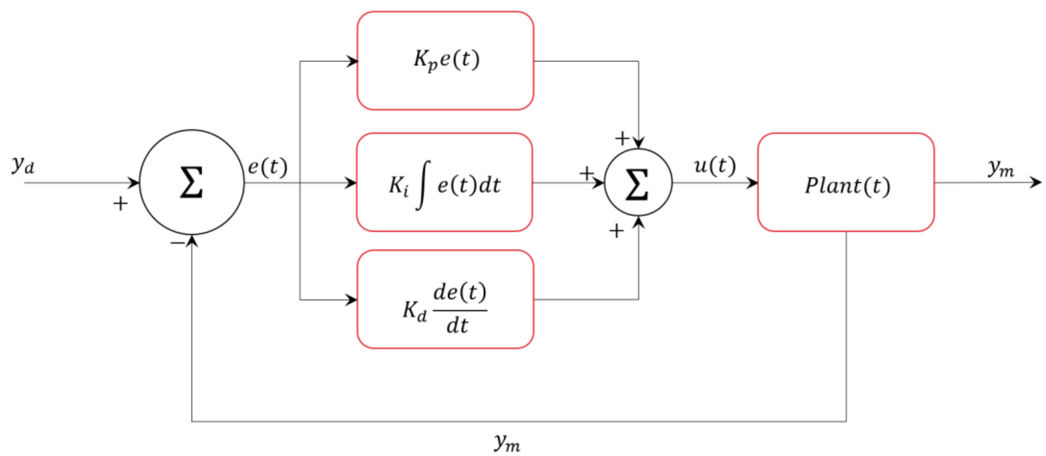

Figure 1: PID Control block diagram for a generic plant

From Figure 1 we can deduce the control action $u(t)$ to be the summation of the three terms in a PID controller.

$$u(t) = K_p e(t) + K_d \frac{e(t)}{dt} + K_i \int e(t)dt$$

$$U(s) = K_p E(s) + K_d E(s)s + K_i \frac{E(s)}{s}$$

Where the goal of the control input $u(t)$ is to minimize the error $e(t)$ over time.