Exploiting Actuator Limits with Feedforward Control based on Inverse Models

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Feedforward control based on inverse dynamic plant models (linear or nonlinear) is a suitable method to enhance set-point tracking performance of control systems. Modelica as equation-based modeling language provides a powerful possibility to automatically generate inverse dynamic models. In many cases inverse models can directly be derived from forward models. Details about model inversion with Modelica can be found in [1].

In reality actuators always have limits, but limiting functions can not be inverted. A common approach to handle this issue is to invert the unlimited plant model and detune the feedforward filter in order to stay always in between the actuator limits. This approach causes a loss in performance for rapid set-point changes, because the actuator range is not entirely used. In this article a rather simple but powerful method is presented, which overcomes this performance issue for many types of plant models. Actuator limits are fully exploited, and the obtained trajectories are close to optimal ones. Simulation and measurement results (see Figure 1) demonstrate the usability of the proposed feedforward structure.

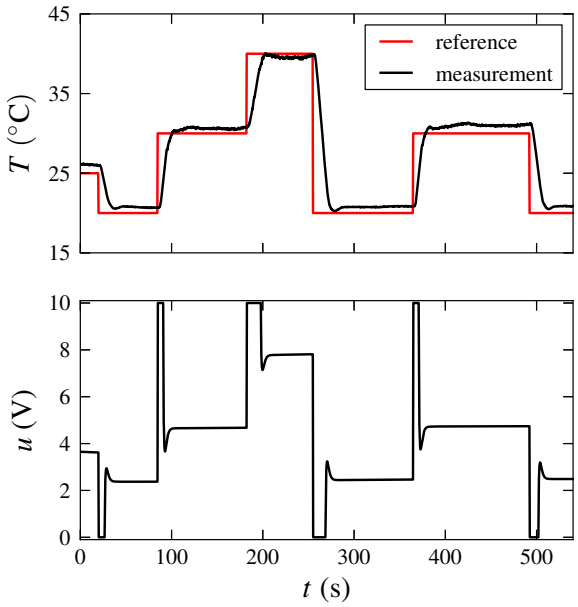

Figure 1: Measurement results from feedforward control of a liquid heater. Using an inverse plant model and a reference trajectory for the temperature T, almost time-optimal plant input values (u) are computed.

References

[1] Gertjan Looye, Michael Thümmel, Matthias Kurze, Martin Otter, and Johann Bals. Nonlinear Inverse Models for Control. In *Proc. of the 4th International Modelica Conference*, Hamburg, 2005.