Feedforward Tuning with Input Nonlinearities

Feedforward Tuning with Input Nonlinearities: Application to Magnetic Saturation in Wirebonders[1]

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1 Background

The increasing demands on throughput and accuracy of semiconductor manufacturing equipment necessitates accurate feedforward motion control that includes compensation of input nonlinearities. In [1], iterative learning control with polynomial basis functions (ILCBF) is introduced to enable extrapolation of the motion tasks. To achieve high tracking accuracy and task flexibility for nonlinear systems, extensions are necessary that compensate input nonlinearities, e.g., magnetic saturation in linear actuators [2].

2 Problem formulation

The aim of this research is to develop a data-driven feedforward tuning approach consisting of a Wiener feedforward, i.e., linear parameterization $F(\theta)$ with an output nonlinearity $h(\cdot,\phi)$, see Fig. 1, for Hammerstein systems.

3 Approach

The developed approach exploits norm-optimal iterative learning control (NOILC) to learn a feedforward signal from data that minimizes the error and utilizes a control-relevant cost function to learn θ, ϕ of the Wiener feedforward [3].

4 Results

Experimental results, see Fig. 2, on a wirebonder subject to magnetic saturation show a reduction in tracking error using the developed approach compared to the linear approach. Moreover, for motion tasks with varying maximum accelerations, the mass parameter is significantly more consistent in the developed approach, indicating task flexibility.

5 Conclusion and outlook

The developed Wiener feedforward approach achieves high tracking accuracy and task flexibility for Hammerstein systems. Ongoing research focuses on online learning in an ILC setting, extensions to non-parametric models for h, and analysis of position dependency of the magnetic saturation.

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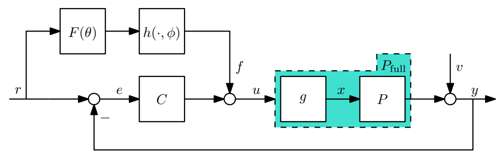

Figure 1: Proposed control scheme with Wiener feedforward $f = h(F(\theta)r, \phi)$.

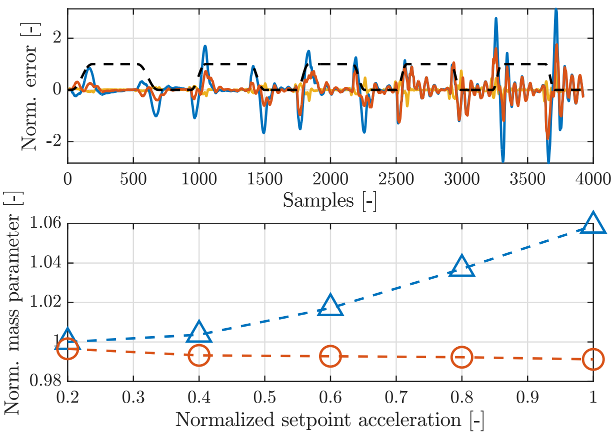

Figure 2: Top: error signals of linear (—), the developed (—), and NOILC (—) approach. Bottom: mass per setpoint acceleration of linear (-△-) and the developed (-⊖-) approach.

References

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