Learning Control without Prior Models
Multi-Variable Model-Free IIC Applied to an Industrial Printer

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1 Background

Iterative Learning Control (ILC) can significantly increase the performance of mechatronic systems that perform repeating tasks [2]. High performance is achieved by learning from the tracking error of previous tasks. The main challenge in ILC is to ensure convergence by suitable design of a learning filter and robustness filter. Typical approaches to design these filters require prior knowledge in the form of a plant model.

2 Problem

Although ILC design approaches have been thoroughly developed, they are relatively demanding in terms of modeling and design effort. This holds especially for multi-variable (MIMO) systems, since these typically require multiple experiments to be identified, and the directionality aspects make the design of robustness filters relatively involved [1]. The aim of this research is to reduce the requirements on modeling and design by developing a data-driven iterative control method for MIMO systems.

3 Approach

A Model-free Inversion-based Iterative control method [3] is developed for MIMO systems. In this approach, input-output data from previous trials is used to estimate an inverse FRF model of the plant, which is used to achieve convergence, without having to use a robustness filter. In this way, the modeling and design requirements are significantly reduced with respect to pre-existing ILC approaches.

4 Results

The developed approach was applied to an industrial wide-format printer to control the x, y and φ degrees of freedom, as is schematically shown in Figure 1. The initial error and final error are displayed in Figure 2, which shows that high performance was achieved after a few iterations. It is concluded that high performance can be achieved through data-driven learning, which does not require a prior system model and expert design skills of the user.

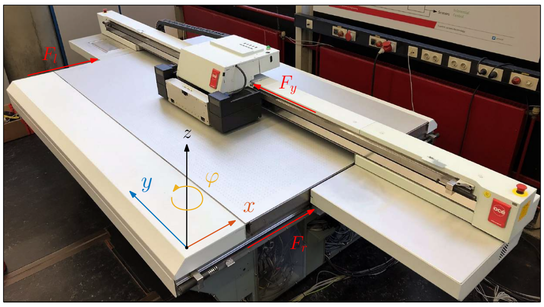

Figure 1: The carriage of the Arizona flatbed printer is controlled in its planar coordinates y, x and φ, by using the actuator forces F_y, F_l and F_r.

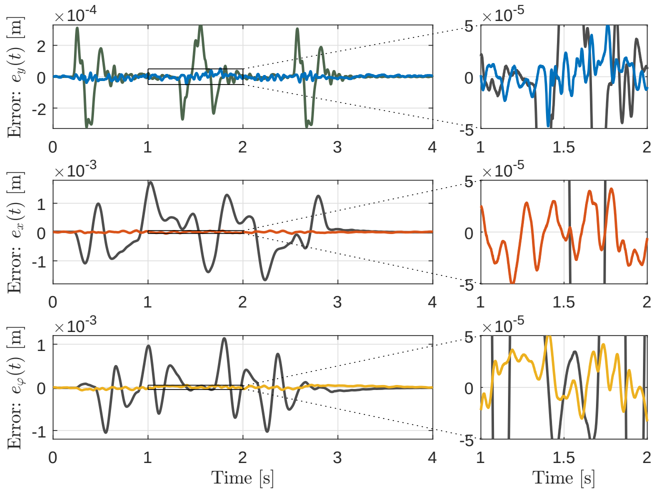

Figure 2: The initial error $e_0(t)$ (——) and the final error $e_{20}(t)$ for the y (——), x (——) and φ axis (——).

References

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[2] de Rozario, R., Fleming, A.J. and Oomen, T., 2016. Iterative control for periodic tasks with robustness considerations, applied to a nanopositioning stage. IFAC-PapersOnLine, 49(21), pp.623-628.

[3] de Rozario, R. and Oomen, T., 2018, March. Improving transient learning behavior in model-free inversion-based iterative control with application to a desktop printer. In Advanced Motion Control (AMC), 2018 IEEE 15th International Workshop on (pp. 455-460). IEEE.