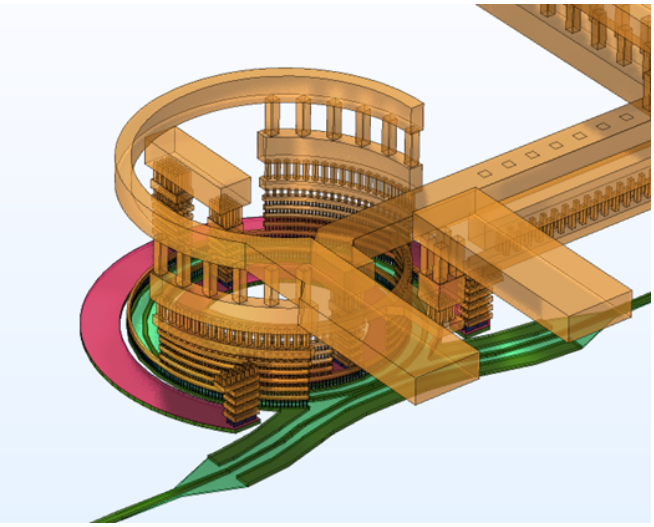
Chair of
Automatic Control

FAU

Research Project

Modified Smith Predictors for Disturbance Rejection

Motivation



Time delays are common in many industrial control systems and often lead to poor performance, especially under disturbances. The classical Smith Predictor [2] is a well-known method to handle such delays but has significant limitations when there are mismatches between the model and the actual process or when delays vary. To overcome these issues, several modified versions of the Smith Predictor have been proposed, including those by Majhi and Atherton, which aim to improve robustness and disturbance rejection [1].

In the context of photonic integrated circuits—especially microring resonators—control is further complicated by fast-changing perturbations and non-negligible system delays introduced by data converters such as DACs and ADCs. These delays are often unavoidable in practical implementations, where thermal tuning or active feedback is required to stabilize resonator performance under varying conditions. Consequently, delay compensation strategies such as modified Smith Predictors may offer practical benefits for improving stability and responsiveness in these high-speed systems [3].

Task Description

The project will begin with a study of the original Smith Predictor and its key modifications. Their limitations will be examined with particular attention to how each version enhances disturbance rejection and robustness to model uncertainties. These predictor strategies will then be implemented and applied to a Micro Ring Resonator model, where fast perturbations and practical system delays—such as those from DAC/ADC interfaces—present realistic challenges. Simulations will be conducted to evaluate the effectiveness of each approach in stabilizing and controlling the resonator system.

Requirements

Attendance in RTA, DCS, or any basic control systems lecture is expected. Basic knowledge of MATLAB and Simulink is required. This project can be written in either German or English.

References

[1] S. Majhi and D.P. Atherton. Automatic tuning of the modified smith predictor controllers. In *Proceedings of the 39th IEEE Conference on Decision and Control (Cat. No.00CH37187)*, volume 2, pages 1116–1120 vol.2, 2000.

[2] O. Smith. Closer control of loops with dead time. 1957.

[3] Chen Sun, Mark Wade, Michael Georgas, Sen Lin, Luca Alloatti, Benjamin Moss, Rajesh Kumar, Amir H. Atabaki, Fabio Pavanello, Jeffrey M. Shainline, Jason S. Orcutt, Rajeev J. Ram, Miloš Popović, and Vladimir Stojanović. A 45 nm cmos-soi monolithic photonics platform with bit-statistics-based resonant microring thermal tuning. *IEEE Journal of Solid-State Circuits*, 51(4):893–907, 2016.

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