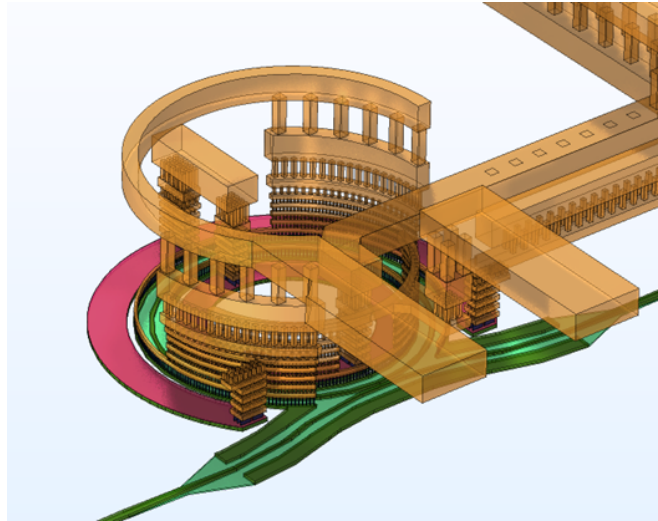


Programming Project

UKF-Assisted MPC of Nonlinear Microring Resonators

Motivation

Microring resonators are compact, energy-efficient building blocks in silicon photonics, enabling wavelength-selective filtering, high-speed optical switching, and on-chip signal routing in dense photonic networks. However, their resonance is highly sensitive to fabrication variations and temperature-induced drifts, requiring continuous and precise tuning to maintain optimal performance. To address this, a nonlinear model predictive control (NMPC) framework can be employed for active wavelength stabilization and power management. Because MPC is state-dependent, an observer is required; given the system's inherent nonlinearities,



a nonlinear observer such as the Unscented Kalman Filter (UKF) is appropriate to provide accurate state estimation under varying operating conditions.

Task Description

The UKF and MPC (via the toolbox GRAMPC) shall be implemented in MATLAB/Simulink and integrated for closed-loop control of the microring resonator. Benchmarking will be conducted using defined operating and disturbance profiles (steps, ramps, noise, parameter drift, latency/quantization), assessing controller and observer performance in tracking, constraint satisfaction, estimation quality, robustness, computational load, and closed-loop stability.

Requirements

Candidates should have completed the "Numerical Optimization and Model Predictive Control" lecture and possess strong programming skills in C/C++.

References

Contact

Mehdi Koochak, M.Sc.
Chair of Automatic Control
mehdi.koochak@fau.de