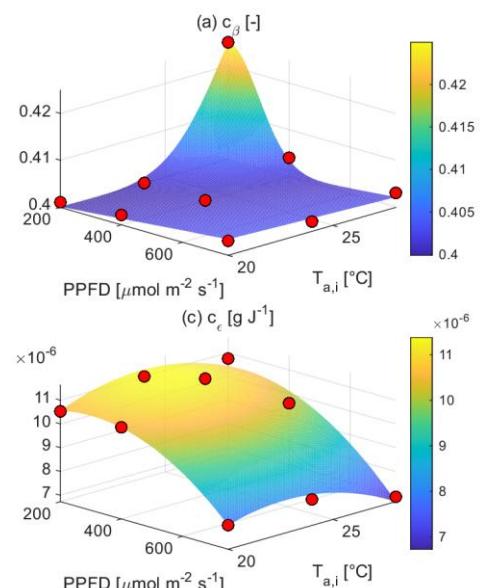


Master / Bachelor / Research Project *

Model-based Sensitivity Analysis of an Indoor Vertical Farm for Optimal Control Design

Controlled-environment agriculture (CEA) offers a pathway to resilient, climate-independent food production. However, the high energy demand of components such as LED lighting and HVAC systems remains a major economic and ecological bottleneck. To minimize the carbon footprint of these facilities, advanced control strategies, such as Model Predictive Control (MPC)—are required to dynamically optimize climate conditions for both plant growth and energy efficiency.

At the professorship we use, among others, a non-linear, mechanistic model of an Indoor Vertical Farm (IVF) that couples thermodynamic principles with a dynamic biological growth model for lettuce. The model accounts for complex interactions, such as the dependency of biological parameters on temperature and light intensity, as well as the behavior of HVAC components under varying outdoor conditions. However, to design robust controllers, it is crucial to understand which of the many system parameters (e.g., heat transfer coefficients, biological growth rates etc.) have the most significant impact on the system's outputs, such as biomass yield and energy consumption. The outcome of this thesis will directly influence the design of future control algorithms and sensor configurations, providing a tangible contribution to sustainable agriculture.



Task description

- Familiarization with the provided state-space model
- Literature research on local and global sensitivity analysis methods
- Implementation of selected sensitivity analysis algorithms to test the model's robustness against parameter uncertainty and disturbances
- Design and simulation of scenarios to quantify the influence of specific parameters
- Recommendation of parameter ranges to show controller robustness
- Documentation of the results

Requirements: Background in Control Engineering or similar

Start: ca. March 2026

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What to expect: During your research you can expect close guidance, while also maintaining freedom in how you approach the tasks. Through intermediate presentations you can prepare for your final defense and gather feedback from multiple team members throughout your project. The thesis can be written and supervised both in English or German, if your study regulations allow.

* Depending on your background and interests, the task can be adapted to fit master, bachelor or research project.