TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
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M A S T E R ' S T H E S I S
for
xx
Student ID xx, Degree xx

Neural MPC for Ventilation Control in Greenhouses

Problem description:

Background: Greenhouses offer a viable solution for year-round crop production, protecting plants from adverse weather conditions and optimizing growing environments. However, greenhouses face their own set of challenges, such as maintaining optimal temperature and humidity levels, managing pests, and ensuring energy efficiency. Balancing these factors is essential to maximize productivity while minimizing environmental impact and operational costs.
Objectives: The primary goal of this master's thesis is to develop an optimal control strategy for greenhouses that maintains ideal temperature and humidity levels for plant growth by controlling the lateral and top vents. While greenhouse environment modeling and control have been extensively studied [1, 2], a major ongoing challenge is to create a model representation of the greenhouse climate that enables the development of a controller easily adaptable across different greenhouses. This remains an unresolved issue because the model parameters often need to be tuned for each specific greenhouse, limiting the scalability of existing solutions. This thesis aims to address this problem by developing a model and control algorithm that generalizes well across different greenhouses without the need for individual tuning. The approach involves designing a model that can be efficiently learned from a dataset from a greenhouse in Spain and is robust against measurement and input noise. Furthermore, a closed-loop optimal control strategy based on this model represented by a neural network (e.g., Neural MPC [3]) is required. This involves the design of a cost function that balances optimal temperature and humidity conditions while considering hard constraints on external factors such as wind and precipitation. The approach should also be capable of continuous learning, incorporating new data points in real-time as the algorithm runs, thereby enhancing adaptability and performance over time.
The thesis will be co-supervised by the Institute for Automatic Control and Systems Engineering at the University of Almeria, Spain.

Tasks:

- Literature review on greenhouse climate control and neural mpc
- Data analysis of data set and implementation of neural network
- Development of an appropriate cost function for the MPC
- Implementation and evaluation of the developed concept
- Report and presentation

Bibliography:

[1] M. Guesbaya, F. García-Mañas, H. Megherbi, and F. Rodríguez, "Real-time adaptation of a greenhouse microclimate model using an online parameter estimator based on a bat algorithm variant," *Computers and electronics in agriculture*, vol. 192, p. 106627, 2022.
[2] F. García-Mañas, T. Hägglund, J. L. Guzmán, F. Rodríguez, and M. Berenguel, "A practical solution for multivariable control of temperature and humidity in greenhouses," *European Journal of Control*, vol. 77, p. 100967, 2024.
[3] T. Salzmann, E. Kaufmann, J. Arrizabalaga, M. Pavone, D. Scaramuzza, and M. Ryll, "Real-time neural MPC: Deep learning model predictive control for quadrotors and agile robotic platforms," *IEEE Robotics and Automation Letters*, vol. 8, no. 4, pp. 2397–2404, 2023.

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Start:	asap
Intermediate Report:	xx
Delivery:	xx

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