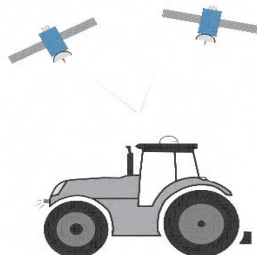




# Nonlinear Model Predictive Control for Agricultural Machine Depth Control

## Background

The chair of agrimechatronics is currently searching for a master's thesis student to explore the application of Nonlinear Model Predictive Control (NMPC) in the context of agricultural machinery. The primary objective of this thesis is to develop an NMPC-based control system to regulate the working depth of an agricultural machine, thereby optimizing its performance in various field conditions.



$$\dot{x}(t) = f(x(t), u(t)),$$

$$x(0) = x_0,$$

$$x_{\min} < x(t) < x_{\max},$$

$$u_{\min} < u(t) < u_{\max}$$

## Thesis task

This research project encompasses several key tasks:

- **System Modeling:** The task is to find, apply and optionally extend modeling strategies in the literature for the agricultural machine's dynamics that accurately represent the system's behavior. The model must be usable within the MPC environment, which requires a limited computational burden and a differentiable mathematic representation of the governing equations.
- **Parameter Identification:** To make the model of the previous step match with the test setup, certain parameters such as dimensions, delays, and more need to be measured or identified.
- **Implementation on Prototype Hardware:** This phase of the thesis centers on the practical aspects of control system development, focusing on implementing the NMPC algorithm on prototype hardware like microcontrollers or embedded systems. The goal is to ensure real-time control capabilities and compatibility with the chosen hardware platform.
- **Experimental Trials:** To validate the effectiveness of the NMPC-based depth control system, experimental trials will be conducted in a field test at the chair. These trials aim to first test the overall effectiveness of the system after tuning and secondly assess the robustness to varying operating conditions.

## General

The theoretical part of the thesis can be done at your own pace and in your favorite working environment. Regular meetings (weekly or biweekly) with the advisor are compulsory. Preliminary tests on agricultural machines are feasible with different vehicles in Dürnast.

A profound motivation for the topic is the only requirement for working on this thesis. Previous experience in control, real-time programming, and system modeling will initially help you but are optional. As a benefit, we offer a high degree of freedom during the thesis for your personal preferences and solution strategies. This, in turn, requires structured and independent work.