

Masterthesis

Robust model predictive control (MPC) for modular multilevel converter (MMC)

Description

The modular multilevel converter (MMC) is a key technology for high-voltage dc (HVDC) transmission and medium-voltage drives. Its many coupled states, nonlinearities, and strict operating limits require advanced control, such as model predictive control (MPC), to ensure safe operation.

Every MPC relies on a model, and no real converter matches it exactly: parameters drift and the model is deliberately simplified. As a result, predicted trajectories look admissible while the real currents and voltages leave their limits. Penalizing violations more heavily does not help, because the guarantee only ever holds for the prediction model. Robust MPC restores it by accounting for the uncertainty explicitly, through constraint tightening or tube-based MPC. This thesis applies both to the MMC and determines which is computationally feasible in real time.

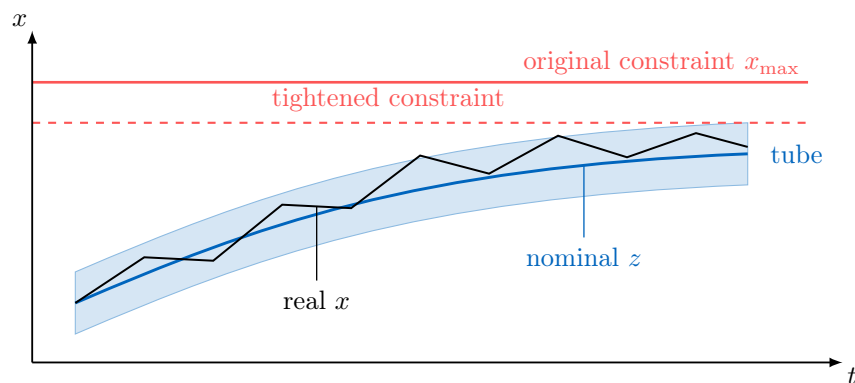


Figure 1: Robust MPC: the constraint is tightened by the size of the tube, so that the real trajectory respects the original limit.

Tasks

- State of the art of robust MPC: min-max, tube-based and constraint tightening formulations.
- Quantification of the uncertainty set of the MMC model.
- Design and implementation of different schemes (e.g. tube-based MPC and constraint tightening).
- Implementation of the proposed algorithms in Matlab & Simulink.
- Experimental validation on the real setup (see figure 2).

What we offer

- Work on a real MMC testbench: your algorithm runs on actual hardware, not only in simulation.
- Results can form the basis for a scientific publication.
- Dedicated student workplaces right next to the lab.
- Robust MPC is an active research field; you learn how to give guarantees under uncertainty, a skill that carries over to many safety-critical systems.
- Start date is flexible.

Prerequisites

- Solid background in control engineering, in particular state-space methods and linear algebra; prior exposure to MPC is helpful.
- Experience with Matlab & Simulink.
- Analytical way of thinking and enjoyment of working with theory and simulation.

Contact and further information

- The thesis can be written in English or German.
- Supervision by Leonardo Testa, M.Sc., with weekly meetings.

For questions and application contact Leonardo Testa, M.Sc. (leonardo.testa@hm.edu).

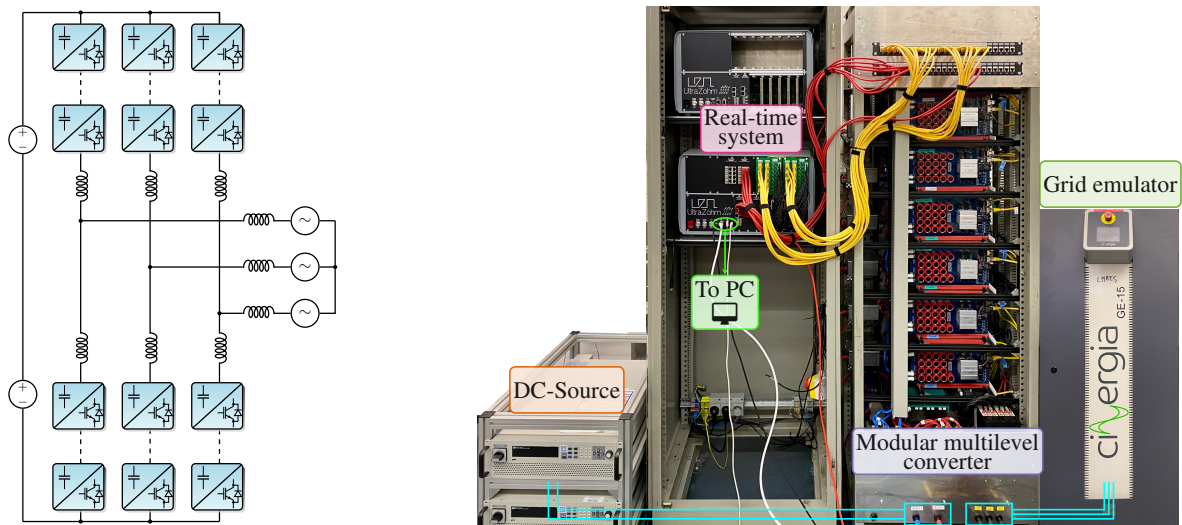


Figure 2: MMC schematic and testbench