Master Thesis AI-based Power Electronics Control

Kennziffer 744000145673749

Job Description

Modern power electronic systems, specifically AC/DC and DC/DC converters, are the vital backbone of tomorrow's technological landscape:

- In E-Mobility, they enable ultra-fast, highly efficient onboard charging systems and robust power delivery.
- In Robotics, they drive the high-dynamic, precise actuators and electric drives necessary for collaborative and autonomous systems.
- In Data Centers they ensure maximum energy efficiency, power density, and uninterrupted operations.

To meet the strict efficiency and volume requirements of these applications, modern power electronics increasingly employ advanced soft-switching topologies. While these topologies significantly reduce switching losses and maximize power density, they exhibit highly non-linear dynamics. Concurrently, cost and space optimization demand smaller energy storage components (capacitors and inductors), which further intensifies system instability and complex dynamic behavior. Traditional linear control methods (like standard PI controllers) struggle to maintain optimal performance under these challenging conditions.
This Master Thesis aims to explore, compare, and implement next-generation closed-loop control algorithms to handle these non-linearities and push the boundaries of converter performance.

- During your thesis, you will select the most promising control concept and design a tailor-made control strategy using an already existing simulation model of our next-generation charger/converter topologies.
- You will investigate advanced closed-loop control methodologies suitable for highly non-linear power electronics, with a focus on Model Predictive Control (MPC), Neural Network-based control architectures and Reinforcement Learning (RL) approaches for power converters.
- Furthermore, you will implement the developed control algorithm in a simulation environment (e.g., MATLAB/Simulink, Python or PLECS).
- Besides, you will validate and benchmark the control concept under realistic operating conditions, evaluating transient behavior, efficiency, and stability compared to state-of-the-art baseline controllers.
- You will analyze and benchmark the identified control strategies regarding execution effort, dynamic response, robustness against parameter variations, and suitability for real-time implementation.
- Last but not least, you will do the documentation and presentation.

Qualifications

- **Education:** Master studies in the field of Electrical Engineering, Control Theory, Mechatronics, Cybernetics, Computer Science or comparable
- **Experience and Knowledge:** strong background in control systems (state-space, non-linear control, or predictive/modern control methods); proficient with simulation tools such as MATLAB/Simulink and/or Python with machine learning frameworks such as PyTorch; knowledge of power electronics (AC/DC and DC/DC converters) is an advantage
- **Personality and Working Practice:** you are a goal-oriented and motivated person with a solution-oriented mindset
- **Work Routine:** we offer you the opportunity to work in a hybrid setup
- **Enthusiasm:** high motivation to work on cutting-edge research at the intersection of power electronics and intelligent control systems (machine learning, reinforcement learning)
- **Languages:** business fluent in English or German

Additional Information

Start: according to prior agreement
Duration: 6 months

Requirement for this thesis is the enrollment at university. Please attach your CV, transcript of records, examination regulations and if indicated a valid work and residence permit.

Diversity and inclusion are not just trends for us but are firmly anchored in our corporate culture. Therefore, we welcome all applications, regardless of gender, age, disability, religion, ethnic origin or sexual identity.

Need further information about the job?
Michael Jiptner (Functional Department)
+49 711 811 45208

Work #LikeABosch starts here: Apply now!

#LI-DNI

www.boschrexroth.de

apply now