

# Intelligent Control Strategies for Nonlinear Systems

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## Summary

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*The aim of the PhD project is to develop novel control methods for nonlinear dynamical systems with emphasis on energy and power systems domain. The developed methods will be based on combining the flatness-based feedforward control with the ideas from event-based control approach. There are different theoretical and practical aspects that the PhD candidate can study within the project.*

Research field:	Information and communication technology
Supervisors:	Prof. Dr. Juri Belikov Dr. Arvo Kaldmäe
Availability:	This position is available.
Offered by:	School of Information Technologies Department of Software Science
Application deadline:	Applications are accepted between June 01, 2023 00:00 and June 30, 2023 23:59 (Europe/Zurich)

## Description

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The proposed PhD project deals with developing novel intelligent control strategies for nonlinear systems with emphasis on energy and power systems domain. The project follows the idea that modern control methods should be applicable to complex systems, be responsive to disturbances as well as they should be resource aware. For the latter, the project focuses mainly on the concept of event-based control. A major part of the project will be devoted to study of disturbance observers and disturbance observer-based control to estimate and compensate disturbances affecting the system dynamics. Such generality allows the potential PhD student to work in many different theoretical and practical problem areas such as stability of dynamical systems, decision-making, observer design, controller design with a primary focus on energy systems. Some of the possible research questions are as follows:

- What are the best methods for designing disturbance observers?
- How to choose the best time for event generation?
- How can we use event-based mechanism to enhance integration of renewable energy sources?

The PhD candidate is expected to contribute to theoretical aspects as well as to practical aspects such as running simulations, planning experiments, and supervision of students. More detailed tasks can be agreed based on the knowledge and experience of the potential PhD candidate.

It is assumed that the PhD candidate is familiar with the basic definitions and concepts used in nonlinear control theory and has some basic knowledge from power system domain. Previous knowledge on event-based control or disturbance observers is seen as an advantage as they are one of the main concepts used in the project.

Supervisor: Dr. Arvo Kaldmäe

Co-supervisor: Prof. Dr. Juri Belikov

## Responsibilities and (foreseen) tasks

- Develop algorithms related to flatness-based control and disturbance observers
- Run simulations and plan experiments
- Supervise students
- Present results to members of the research group and at international conferences

## Applicants should fulfil the following requirements:

- a master's degree in mathematical control theory, systems and control, applied mathematics or related fields
- strong background in nonlinear control theory
- basic knowledge from power system domain



- knowledge of Matlab/Simulink
- excellent communication skills in oral and written English
- previous research experience

**The following experience is beneficial:**

- Previous knowledge on flatness and/or disturbance observers

**We offer:**

- A fully paid 4-year PhD position
- The chance to do high-level research
- Opportunities for conference visits and research stays at collaborating universities and research centers

**About the department**

The mission of the Department of Software Science at Tallinn University of Technology is to advance internationally and nationally relevant state of the art in research and apply it in bachelor, MSc and doctoral education in the areas of computer science, information systems, data science, artificial intelligence and cyber security with the goal to solve problems the society is facing and support sustainable development. The research groups and laboratories are autonomous, strong and successful participants in attracting research funding and are able and willing to participate in research and innovation heavy collaboration with enterprises and the public sector, both in Estonia and abroad.

The nonlinear control systems group is a leading Estonian research unit in automatic control, focusing on nonlinear control systems, including non-smooth, hybrid and time-delay systems. The group has made a significant contribution to the development of constructive algebraic methods and the associated symbolic software package NLControl, which supports research, teaching and applications. Although the group is developing predominantly application-independent general methods determined by the dynamic properties of the mathematical models, we have been recently focused on a few carefully chosen application areas. One of these concerns practical problems arising in limits of renewable energy integration and determining the possible limitations of distributed energy storage devices in low inertia power systems.

**Additional information**

For further information, please contact Arvo Kaldmäe [arvo.kaldmae@taltech.ee](mailto:arvo.kaldmae@taltech.ee) and Prof. Juri Belikov [juri.belikov@taltech.ee](mailto:juri.belikov@taltech.ee)



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