Disturbance observer based control of nonlinear systems

Summary

The aim of the PhD project is to study possibilities to estimate disturbances affecting the dynamics of nonlinear control systems and methods to design control techniques that use these estimations. For disturbance estimation, the goal is to transform the dynamics of a nonlinear control system to special forms for which the disturbance estimation problem becomes easier to solve using known results. 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 October 02, 2023 00:00 and October 23, 2023 23:59 (Europe/Zurich)

Description

Supervisor: Arvo Kaldmäe
Co-supervisor: Juri Belikov

The research
The proposed PhD project deals with estimating disturbances affecting nonlinear control systems and designing disturbance observer based control methods. Many popular control methods can be improved by simply designing them in such a way that the estimations of the disturbances are taken into account when computing the control input. The most popular disturbance estimation methods assume the system dynamics to be in a specific form. A major part of the project will be devoted to transforming nonlinear systems into forms for which the design of disturbance observers becomes much easier task and implementing such algorithms. One can work with many different theoretical and practical aspects of the problem. It is expected that the student contribute to theoretical and practical aspects. Specific 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. Previous knowledge on disturbance observers is seen as an advantage as it is the main concept used in the project.

Responsibilities and (foreseen) tasks

- Prove theorems
- Develop algorithms
- Run simulations
- Present results

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 or mathematics
- excellent communication skills in oral and written English
- previous research experience

The following experience is beneficial:

- Previous knowledge on 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.

For further information, please contact Arvo Kaldmäe arvo.kaldmae@taltech.ee or Juri Belikov juri.belikov@taltech.ee

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