Fractional-Order Modelling and Control Methods for Industrial-Grade Complex Dynamic Systems

Summary

The core objective of this doctoral research is to develop and refine advanced methods for modeling and controlling complex dynamic processes in industrial environments, with a particular focus on enhancing the capabilities of the FOMCON ("Fractional-Order Modeling and CONtrol") toolbox towards achieving these goals. This entails investigating both theoretical and applied aspects of fractional-order calculus, nonlinear system identification, and distributed control strategies, as well as ensuring that these innovations can be seamlessly integrated into industrial workflows with the help of FOMCON toolbox.

Research field:	Information and communication technology
Supervisor:	Prof. Dr. Eduard Petlenkov
Availability:	This position is available.
Offered by:	School of Information Technologies Department of Computer Systems
Application deadline:	Applications are accepted between January 01, 2025 00:00 and January 24, 2025 23:59 (Europe/Zurich)

Description

The research will extend classical modeling approaches by incorporating emerging techniques such as fractional-order modeling and symbolic regression. By leveraging the FOMCON toolbox, novel fractional-order control schemes will be designed, analytically verified, and validated in laboratory settings. Through iterative refinement, these methods will be tailored for deployment in cyber-physical systems, distributed control systems (DCS), and internet-of-things (IoT) platforms, making them readily transferable to industrial contexts.

This work aims to bridge existing gaps between cutting-edge academic research and the practical needs of industry. By enabling more accurate system simulation, robust control, and improved adaptability in complex systems—ranging from manufacturing lines to HVAC installations—the enhanced FOMCON-based solutions will facilitate smarter automation strategies. Ultimately, the improved control architectures developed in this project will offer measurable benefits, including enhanced control loop performance, more efficient resource utilization, and the improvement of relevant key performance indicators in real-world industrial applications.

Requirements for the candidate's background and knowledge:

- Good knowledge of dynamic modelling and control theory;
- Good knowledge of Intelligent control algorithms and/or fractional order modelling and control;
- Good knowledge of numerical optimization methods;
- Excellent knowledge of MATLAB/Simulink;
- MSc in a related field;
- Outstanding master thesis in the field of control theory;
- At least one published paper in the field of the research in a journal with impact factor higher than 4 in which the candidate is the first author;
- Good knowledge of Computational Intelligence methods and learning algorithms is a benefit.

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