Estimation and Control-Based Interval Methods of Uncertain Systems

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Invited Session Proposal

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1 Session Topic and Goals

The key aspects of this invited session are methods for estimation and control of dynamical systems which take into account the presence of uncertainty and disturbances due to measurement noise, unknown parameters, or unknown inputs. In recent years, the importance of dealing with uncertainty when designing estimators and controllers has been fully recognized. Examples of uncertain systems can be found in many applications. Some of which are robotic manipulators or chemical reactors. In the former, the inertia as seen by the drive motors depends on end-effector positions and load masses so that the dynamical model itself varies with the robot's attitude. In the latter case, transfer functions strongly depend on the mix of reagents and catalysts and may change temporally as the reaction progresses [Clarke, 1996]. Thus, efficient methods with high performance guarantees are required for state and disturbance estimation as well as for control of uncertain systems in a wide range of real-life applications.

Interval methods are mathematical tools that are used to put bounds on an unknown state in mathematical computation. These methods can guarantee reliable and mathematically correct results. Instead of representing a value as a single number, interval methods represent each value by means of an enclosure with floating point bounds. Over the past few years, interval methods for estimation and control have gained an increasing interest by a continuously growing number of researchers whose work deals with aspects such as interval observers, set-membership filters, and a controller synthesis based on interval estimation for various families of dynamical systems, see the books [Cacace et al., 2016; Dinh, 2014; Rauh and Senkel, 2016].

This session presents current research work in the frame of interval methods aiming at the estimator and

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controller design for systems that are modeled by differential and difference equations in which uncertain terms are introduced to reflect aleatory uncertainty (describing random effects such as measurement noise) and epistemic uncertainty (due to a lack of knowledge wrt. the precise system structure or specific parameters). The organizers encourage the presentation of research work related but not limited to observer design, filtering, feedback control, identification, (on-line) model predictive and fault-tolerant control of uncertain systems using interval methods. Therefore, the goal of this invited session is to bring together researchers who employ interval methods for modeling, estimation, control and approximation, to present the benefits in numerous use cases of interval methods dealing with uncertain systems to the broad control community, and to stimulate further activities in this important research area. The proposed invited session will provide a forum for presenting and discussing the latest developments on theoretical and computational aspects of interval methods in control and observation of uncertain systems by both junior and senior faculties across different academic disciplines (electrical engineering, mechanical engineering, chemical engineering) and from different geographic regions. While all the papers center around the theme of the session, they cover a wide range of theoretical and application topics of great interest to control researchers from academia and industry.

2 References

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F. Cacace, L. Farina, R. Setola, A. Germani (Eds.), *Positive Systems*, Lecture Notes in Control and Information Sciences LNCIS, Volume 471, 2016

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A. Rauh, L. Senkel (Eds.), *Variable-Structure Approaches: Analysis, Simulation, Robust Control and Estimation of Uncertain Dynamic Processes*, Part of the Mathematical Engineering book series (MATHENGIN), Springer, 2016