Set-Valued Approaches to Control and Estimation of Uncertain Systems ⋆

Track Code: td76r

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Abstract: We provide an open invited track for presenting and discussing the latest developments on theoretical as well as computational aspects of set-valued and interval methods in control and estimation of uncertain systems 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 issue, they cover a wide range of theoretical and application topics of great interest to control researchers from academia and industry.

Keywords: Set-valued methods; interval methods; uncertain systems; observer design; feedback control; optimization; (on-line) model predictive control; fault-tolerant control; fault diagnosis.

1. SESSION TOPIC AND GOALS

The key aspects of this open invited track are robust methods for estimation and control of uncertain systems. Examples of uncertain systems can be found in many applications, such as 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 pose whose measurements may be uncertain/noisy. In the latter case, transfer functions strongly depend on the mix of reagents and catalysts and may change temporally as the reaction progresses, which may not be known/modeled exactly. Because modern industrial systems as those mentioned above become more and more complex, uncertainty and disturbances due to measurement noise, unknown parameters, or unknown inputs are unavoidable during the stage of system operation. Dealing with uncertainties plays an important role in the safety and reliability assessment of dynamical systems. Over the last three decades, these topics have attracted an ever growing attention of researchers in the control community. When constructing strategies for state estimation and control, the designed methods should be capable of handling the influence of uncertainty with a reasonable degree of robustness of observation and control. Consequently, efficient methods with high performance guarantees are required for state and disturbance estimation as well as for the control of uncertain systems in a wide range of real-life applications.

A controller manages, commands, directs, or regulates the behavior of the considered plants using control loops. Estimating the current state is crucial to obtain information on the system in real time for controlling its behavior. A common way of addressing this problem is to place some sensors in the physical system and to design an algorithm, called an observer, whose role is to process the incomplete and imperfect information provided by the sensors and thereby to construct a reliable estimate of the whole system state. Such algorithms can exist only if the sensor-based measurements contain enough information to determine the state of the system unambiguously; namely, the system needs to be observable.

This session presents current research work in the framework of set-valued methods such as interval methods aiming at the estimator and 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

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knowledge with respect to the precise system structure or specific parameters). The goal of this track is

(1) to bring together researchers who employ set-valued methods for modeling, estimation, control and approximation,
(2) to present the benefits in numerous use cases of set-valued methods dealing with uncertain systems to the broad control community, and
(3) to stimulate further activities in this important research area.

We encourage the presentation of research works related, but not limited to:

- linear and nonlinear control systems;
- observer design;
- feedback control;
- (on-line) model predictive control;
- fault diagnosis and fault-tolerant control of uncertain systems;

using set-valued and interval methods.