Open invited track proposal

Estimation and Observer Design: Theory and Applications

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Technical committee: CC2 Design Methods
1. **TC2.1: Control Design**
2. **TC2.2: Linear Control Systems**
3. **TC2.3: Non-linear Control Systems**

Abstract
The objective of this open invited track proposal, to be included in the IFAC world congress 2023, which will be held in Yokohama, Japan, July 09-14th, 2023, consists in inviting contributions in the field of linear and nonlinear estimation and their applications in many theoretical and practical problems. The main goal is to bring together experts in the field of estimation and application-oriented researchers to create fruitful discussions on the recent advances and identify some future directions.
Keywords: Estimation; observer design; nonlinear systems; learning-based techniques.

Description

The proposed open invited track session focuses on fundamental issues in estimation theory as well as on applications to real-world models such as biomedical systems, biological processes, smart mobility, economics, and so on. It aims to provide conference attendees with the opportunity to experience state-of-the-art solutions and tools to address any estimation problem, namely optimization-based estimation methods and observer design.

Estimation theory in general, and more importantly state observer design, are increasingly becoming a hot research topic for control design problems under all their aspects. Although they have considerably marked the last decades with remarkable advances in the field, with well-thought-out theoretical contributions, they are coming back even stronger for two reasons. Firstly, with the integration of new technologies in control design systems, new applications have appeared, whose estimation is essential. For instance, we can mention cyber-physical systems where estimation plays an important role for resilience and security, namely detection and estimation of cyber-physical attacks. More recently, estimation has a considerable place in artificial intelligence; there are several estimation methods and observer design based on online learning techniques. On the other hand, there has recently been an awareness of the weaknesses of existing methods that many works attempt to overcome. Among these weaknesses, to name just one, are the required assumptions on the system.

Several powerful techniques for nonlinear estimation and observer design have been developed and explored in the last few years. Further, the need for nonlinear filters and observers has been felt and pursued in many new and essential applications.

Besides the nonlinearity of the system, there are several other families of linear systems which are complex from estimation point of view. Without being exhaustive, we can mention linear systems with unknown inputs, systems with unknown constant parameters, systems in the presence of unknown time-varying delays, and so on. These classes of systems require the development of unknown input observers, adaptive observers, and robust observers. Several challenging issues are related to these topics, namely the requirement of strong rank conditions for the existence of an algorithm allowing estimation of the unknown inputs, the constant parameters, or the unknown delays.

Topics include, but are not limited to:

- State observer design for nonlinear systems: LMI-based techniques, high-gain methodology, sliding mode technique.
- Estimation algorithms based on minimization of cost functions: moving horizon estimators, Kalman filtering.
- Statistical predictors and filters based algorithms.
- Unknown input observers; descriptor systems.
- Application to fault diagnosis.
- Cyber-physical attacks detection.
- Real-world applications: biomedical models; biological processes; vehicle dynamic; economics; and so on.