Hindawi
Mathematical Problems in Engineering
Volume 2018, Article ID 2161456, 2 pages
https://doi.org/10.1155/2018/2161456

*Editorial*

# Advanced Observer-Based Control for Benchmark Control Problems: From Mathematical Modeling to Control Design

**Olfa Boubaker**,[1] **Mihai Lungu**,[2] **Binoy K. Roy**,[3] **and Luis J. Yebra**[4]

[1] *University of Carthage, National Institute of Applied Sciences and Technology, Tunis, Tunisia*
[2] *University of Craiova, Craiova, Romania*
[3] *NIT Silchar, Assam, India*
[4] *Platforma Solar de Almeria, Almeria, Spain*

Correspondence should be addressed to Olfa Boubaker; olfa.boubaker@insat.rnu.tn

Received 12 December 2018; Accepted 12 December 2018; Published 27 December 2018



In the field of control theory, several benchmark systems of high interest exist in the literature and are frequently used as fundamental systems for testing emerging control algorithms. In spite of their simple structure, such systems have the richest dynamics and still refer to challenging control problems.

On the other hand, despite being a relatively old subject in control theory, observer-based control design has regained much interest in the last few years due to its significant potential to solve many engineering problems. The non exact knowledge of systems dynamics, non availability of state measurements, and the presence of uncertainties and perturbations could justify such attention. The separation principle of the controller-observer design is at the heart of this challenging problem in relation to rather conflicting requirements such as stability, performance, and robustness.

The first objective of this special issue is to bring the attention of the scientific community to the importance of mathematical modeling in the field of control systems. Our purpose is also to draw a state of the art of the available benchmarks in this field by focusing on the ability of their mathematical models to solve many complex control problems. These benchmarks include the following engineering applications: industrial applications: rotary drilling system, stirring reactor with heat exchanger, distillation column, chemical reactor, three-tank process, four-tank process, and so on; mechanical applications: mass-spring-damper system, bouncing ball, TORA system, hard-disk drive system, magnetic levitation system, and so on; robotic applications: cart inverted pendulum, Furuta pendulum, reaction wheel pendulum, beam-and-ball, two-link flexible manipulator, and so on; automotive applications: vehicle dynamics system, diesel engine system, battery model, and so on; flight dynamics applications: VTOL aircraft, HL-20 vehicle, 747 Jet aircraft, and so on.

The second objective of this special issue is to propose advanced observer-based control mathematical methods in relation to the latest engineering problems.

A total of 41 papers were submitted for consideration of the special issue and only 9 papers were accepted for publication. Thus, the acceptance rate is less than 22%. Different types of observers are proposed especially where various benchmark systems are considered to implement the proposed observer-based controllers.

In "A Finite-Time Disturbance Observer Based Full-Order Terminal Sliding-Mode Controller for Manned Submersible with Disturbances" by X. Fang and F. Liu, a full-order terminal sliding-mode controller based on the finite-time disturbance observer for the "JIAOLONG" manned submersible with lumped disturbances is proposed. The closed-loop system stability analysis is given by Lyapunov theory. The simulation results demonstrate the satisfactory tracking performance and excellent disturbance rejection capability.

In "Unknown Inputs Nonlinear Observer for an Activated Sludge Process" by F. Smida et al., the authors have proposed a cascaded high gain unknown inputs nonlinear observer for an activated sludge process. The proposed observer not only estimates the ammonia and substrate concentration (unmeasurable states) but also reconstructs the influent ammonia and the influent substrate concentration (unknown inputs). The simulation results are validated with experimental data.

S. Ben Warrad et al. have proposed full and reduced order unknown input observers for a class of linear time-delay systems with multiple delays in their paper titled "Full and Reduced-Order Unknown Input Observer Design for Linear Time-Delay Systems with Multiple Delays". The existence conditions of the two observers are given. The proposed concepts are validated via simulation results using the quadruple-tank benchmark.

In "Sensorless Control for Joint Drive Unit of Lower Extremity Exoskeleton with Cascade Feedback Observer" by P. Pei et al., a cascade feedback observer consists of integral-switching-function sliding mode observer and an adaptive FIR filter is presented. The stability condition of the observer is obtained using Lyapunov theory. Simulations and experiments are carried out to verify its validity.

The paper titled "Attitude Controller Design with State Constraints for Kinetic Kill Vehicle Based on Barrier Lyapunov Function" is submitted by T. Zhang et al. In their paper, a nonlinear disturbance observer is designed for estimation and compensation of uncertainties and disturbances. An adaptive attitude controller is designed for Kinetic Kill Vehicle combining Barrier Lyapunov function with sliding mode controller. Numerical simulations validate that the proposed method can achieve state constraints, pseudolinear operation, and high accuracy.

In "Discontinuous High-Gain Observer in a Robust Control UAV Quadrotor: Real-Time Application for Watershed Monitoring" by A. E. Rodríguez-Mata et al., a high-gain observer based on a discontinuous technique is presented. The high-gain observer estimates external disturbances such as wind and parameter uncertainties. This observer is used to design a robust control algorithm for a quadrotor UAV attitude dynamics to monitor a watershed in real time. Lyapunov stability theory is used during the design. The simulation and experimental results validate the nonlinear observer performance and robustness of the approach under windy conditions.

R. Wang et al. have presented their paper on "Speed Control for a Marine Diesel Engine Based on the Combined Linear-Nonlinear Active Disturbance Rejection Control". A compound control scheme with linear and nonlinear active disturbance rejection controllers along with their switching policy is proposed to control the speed of a marine diesel engine. Linear and nonlinear extended state observers are also used. The simulation results demonstrate that the proposed control scheme has prominent control effects under both the speed tracking mode and the condition with different types and levels of load disturbance.

In "An Optimal Identification of the Input-Output Disturbances in Linear Dynamic Systems by the Use of the Exact Observation of the State" by J. Byrski and W. Byrski, a technique is presented for the estimation of unknown disturbance signals acting in the input and output measurements of a dynamic linear system. Two different integral type state observers are used in parallel for this purpose.

In "A New Direct Speed Estimation and Control of the Induction Machine Benchmark: Design and Experimental Validation" by A. Hmidet et al., a sensorless speed control technique of an induction machine is presented. The speed is estimated based on the measured current and voltage of the stator. Experimental results show that the proposed approach has interesting capabilities to conduct induction motor in real time operation with good accuracy.

## Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this special issue.

## Acknowledgments

The editors would like to express their gratefulness to all authors of the special issue for their valuable contributions and to all reviewers for their helpful and professional efforts to provide precious effective comments and feedback. We hope this special issue offers a wide-ranging and timely view of the area of design of observers and observer-based controllers, which will generate stimulation for further academic research and industrial applications.

*Olfa Boubaker*
*Mihai Lungu*
*Binoy K. Roy*
*Luis J. Yebra*