

# Special Issue: “Control and Automation”

Cristina-Ioana Muresan and Eva H. Dulf \*

Technical University of Cluj-Napoca, Department of Automation, Memorandumului Street, No 28,  
400114 Cluj-Napoca, Romania; Cristina.Muresan@aut.utcluj.ro

\* Correspondence: Eva.Dulf@aut.utcluj.ro

## 1. Introduction

A wide range of ongoing research in the areas of controller design and information engineering reveals that the pace of technological change in this domain seems to be accelerating. The primary focus is on futuristic segments ranging from robotics and genomics to chemical feedstock and electrical storage.

The main objective of this Special Issue was to provide a forum for researchers and practitioners to exchange their latest theoretical and technological achievements and to identify critical issues and challenges for future investigation on topics regarding advanced automation and control techniques based on information system technologies.

## 2. Novel Ideas for Control

The Special Issue focused on original ideas and potential contributions for theory and practice, at the same time. It received a total number of 21 submissions, among which 7 were accepted. These published manuscripts tackle some novel approaches in control, including fractional order control systems, with applications in robotics, biomedical engineering, electrical engineering, vibratory systems, waste water treatment plants.

One of these papers [1] presents a synchronous co-simulation of a 6DOF (six degrees of freedom) ball and plate platform and its 3D computer model intended to simulate the actual dynamics of a rendezvous between a cargo vehicle such as the Falcon 9 from SpaceX and the ISS (International Space Station). A supervisory action is required for initiating the docking mechanism. The novelty of the manuscript consists of an adaptive fractional order control solution. The tuning method is easy and the control strategy is implemented and validated on a laboratory benchmark. The results demonstrate that such an approach is suitable to meet the performance specifications despite the large variability in the system dynamics.

Vibratory systems and an efficient control for these processes are addressed in two of the published papers. One of these [2] tackles the idea of using a fractional order differential equation to model such a process, based on its viscoelastic nature. Then, a fractional order Linear Quadratic Regulator (LQR) is designed. To solve the Riccati equation of the LQR method, an iteration-based approach is proposed. Next, to estimate the states originating from the fractional-order derivative term, a fractional-order state observer is constructed. To demonstrate the efficiency of the proposed control algorithm, numerical simulations are presented showing that vibrations are indeed suppressed. The second paper that deals with vibratory systems uses a smart beam to validate an experimental tuning approach for fractional order proportional–integral–derivative (PID) controllers [3]. The tuning method is based on shaping the Bode magnitude plot, such that the resonant peak is decreased. There is no need for a process model, only several experimental tests are required to obtain the necessary process information at different frequencies. Experimental results are provided to demonstrate the efficiency of the proposed approach.

Both of the algorithms in [2,3] use concepts from fractional calculus. To implement such fractional order controllers, digital realizations are often required which use sample and hold (S&H) circuits to perform the conversion from analog to digital and vice versa.

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An excellent review of these S&H systems, as well as a new fractional order design of such systems, is presented in [4]. The proposed approach models these systems both in the time and Laplace domains and is a generalization of the classical devices, enabling a better understanding of the possibilities and limitations of S&H systems.

The field of biomedical engineering is currently receiving tremendous attention from the research community, especially regarding personalized and optimized medicine. In [5], such a topic is addressed regarding carcinoma models and adequate chemotherapeutic treatment. The core problem in delivering a carcinoma model suitable for developing an optimized therapy consists of the limited number of measurable physiological signals—state variables—and the knowledge of model parameters. The solution proposed in [5] refers to the use of observers. A moving horizon estimation (MHE)-based observer is developed that uses a third-order tumor growth model. The performance of the observer is compared to that of an optimized extended Kalman filter (EKF). Results show that proposed MHE is designed to be suitable for closed-loop applications and yields simultaneous state and parameter estimation.

Novel ideas in the field of optimal battery charging are presented in [6]. A battery model, designed for automotive battery management systems applications, is used to design charging controllers in an optimal charging strategy. The standard model is altered to produce a nonlinear electro-thermal battery aging model, which is linearized in several operating points. An optimal charging strategy is then designed for simultaneous minimization of charging time and maximization of battery lifetime. An optimization problem that minimizes aging is solved to determine an appropriate charging trajectory. The CRONE methodology is then used to take into account the resulting linear model family. Several simulations are employed to show the efficiency of the resulting charge controller.

The Special Issue contains a seventh paper dealing with a weather-based prediction strategy inside the proactive historian with application in wastewater treatment plants [7]. The authors propose a software reference architecture for such a proactive Historian, along with a data dependency identification strategy and some obtained recipes for energy efficiency improvements in the water industry. However, complex research is required in order to offer a complete solution for real industrial processes. Part of this reference architecture that predicts the future evolution of the monitored system is developed in [7]. The design is based on weather dependency and forecast. In this way, the approach paves the way towards achieving a fully functional, real-world, tested and validated proactive Historian application, with potential to bring significant direct benefits to the water industry.

### 3. Conclusions

This Special Issue has gathered a selection of novel research results regarding control systems in several distinct research areas. We hope that these papers will raise new ideas, concepts and further developments in the field.

We wish to thank the authors for considering this Special Issue as a proper way to disseminate their results. Additionally, we thank the reviewers for the extra effort put into reviewing the manuscripts. Last, but not least, we thank the dedicated editorial team of *Applied Sciences*, especially to assistant editor Wing Wang, the Special Issue Managing Editor who provided a lot of help with managing the papers.

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**References**

1. Copot, C.; Muresan, C.I.; Beschi, M.; Ionescu, C.M. A 6DOF virtual environment space docking operation with human supervision. *Appl. Sci.* **2021**, *11*, 3658, doi:10.3390/app11083658.
2. Takeshita, A.; Yamashita, T.; Kawaguchi, N.; Kuroda, M. Fractional-order LQR and state observer for a fractional-order vibratory system. *Appl. Sci.* **2021**, *11*, 3252, doi:10.3390/app11073252.
3. Birs, I.; Folea, S.; Prodan, O.; Dulf, E.; Muresan, C. An experimental tuning approach of fractional order controllers in the frequency domain. *Appl. Sci.* **2020**, *10*, 2379, doi:10.3390/app10072379.
4. Ortigueira, M.D.; Machado, J.T. A review of sample and hold systems and design of a new fractional algorithm. *Appl. Sci.* **2020**, *10*, 7360, doi:10.3390/app10207360.
5. Siket, M.; Eigner, G.; Drexler, D.A.; Rudas, I.; Kovács, L. State and parameter estimation of a mathematical carcinoma model under chemotherapeutic treatment. *Appl. Sci.* **2020**, *10*, 9046, doi:10.3390/app10249046.
6. Mohajer, S.; Sabatier, J.; Lanusse, P.; Cois, O. Electro-thermal and aging lithium-ion cell modelling with application to optimal battery charging. *Appl. Sci.* **2020**, *10*, 4038, doi:10.3390/app10114038.
7. Nicolae, A.; Korodi, A.; Silea, I. Weather-based prediction strategy inside the proactive historian with application in Wastewater Treatment Plants. *Appl. Sci.* **2020**, *10*, 3015, doi:10.3390/app10093015.