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Editorial: Insights in control and automation systems

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Editorial on the Research Topic
Insights in control and automation systems

The aim of this Research Topic is to focus on new insights, novel developments, current challenges, latest discoveries, recent advances, and future perspectives in the field of Control and Automation Systems. Motivated by many factors such as the need of an increased quality of the products, of a reduction of costs and of an increment in flexibility of the production, there has been a tremendous development of industrial control and automation systems in the last decades. In fact, in the context of Industry 4.0 paradigm, with the (almost) full digitalization of the production, control systems play a key role in the different layers of the automation pyramid.

Three papers have been gathered in the Research Topic. The first one deals with education. In it, Rossiter explains that the advancements in control systems and their increased pervasiveness at different levels require to rethink the topics to be taught in a first (possibly unique) control course at the university. In addition, the availability of many resources in the web (such as videos, virtual, and remote laboratories, interactive tools, etc.) can be exploited to improve teaching and to achieve an effective learning for each student. Indeed, the COVID-19 pandemic has pushed instructors to use such a kind of tools and has raised the expectations from the students. A recent survey organized by the Technical Committee on Education of the International Federation of Automatic Control has given guidelines in this context: rather than providing many mathematical details, a first control course should enthused students in order to make them aware of the role of control systems in different fields. Further, software tools and online resources can be exploited to help students in focusing on the main concepts rather than on tedious mathematical calculations (which can be left to subsequent courses), thus making their more prepared to face the diverse problems posed by industry nowadays.

In the second paper, Alfaro and Vilanova address a relevant practical issue when Proportional-Integral-Derivative (PID) controllers are used. PID controllers are the most employed feedback controllers in industry and they represent the fundamental brick of the lowest layer in an automation system. For this reason, it is essential they provide a high performance, in particular if optimization algorithms (for example, model predictive control) are used on their top to define the set-points that optimize the overall production. Since PID controllers can be implemented in different forms (in particular the proportional and/or the derivative action can be applied to the control error or directly to the process variable), it is important to investigate if tuning rules that are designed for a given form provide the required performance and robustness when applied on PID controller with a different form. This concept is denoted as resilience and its analysis highlights the need of carefully considering the PID controller structure when a given tuning rule is selected.

The third paper authored by Birk et al. deals with one of the main topics in Industry 4.0, that is, digital twins. A review is performed in order to discuss the opportunities and challenges of creating and using digital twins for estimation and control of process industrial systems over their life-cycle. The use of digital twins is more and more widespread nowadays because an accurate virtual representation of the physical systems allows, for example, the implementation of algorithms to optimize the operations of the process and for maintenance purposes. The reviews focuses on fundamental aspects of digital twins, that is, on learning (through data-driven approaches), validating, and updating large-scale (plant-wide) equation-based process models. These elements are covered in light of common application scenarios that are also linked to the required technologies and their level of maturity. In addition to a summary of the state-of-the-art for autonomous model development, calibration, monitoring, and updating, the research directions for the creation of a fully autonomous toolset for the automatic production, calibration, and updating of the resulting purpose-oriented digital twins are also outlined.

It is hoped that the readers will find the Research Topic inspiring and a useful reference to better understand the state of the art of some relevant aspects of automation and their future perspectives.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The author AV declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note