mathematics

Editorial

Mathematics in Robot Control for Theoretical and Applied Problems

Paolo Mercorelli [1,*], Oleg Sergiyenko [2] and Oleksandr Tsymbal [3]

[1] Institute for Production Technology and Systems (IPTS), Leuphana Universität Lüneburg, 21335 Lüneburg, Germany
[2] Department of Applied Physics, Autonomous University of Baja California, Mexicali 21100, Mexico; srgnk@uabc.edu.mx
[3] Department of Computer-Integrated Technologies, Automation and Mechatronics, Kharkiv National University of Radio Electronics, 61166 Kharkiv, Ukraine; oleksandr.tsymbal@nure.ua
* Correspondence: paolo.mercorelli@leuphana.de

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1. Introduction to the Special Issue

Technological development has not only boosted the use of mechanical systems for industrial uses but above all has made it possible for them to be used in areas and sectors unimaginable until a few years ago. Mechatronics is the neologism which now indicates in general modern robotic systems which are to be equipped with sophisticated electronic control devices. Such devices are capable of helping systems to achieve high performance and allowing their use and disparate aspects of our daily life. It is a synergy set which can radically change some aspects of the production world. A growing interest toward robots, a special class of mechanical systems, as well as fear and perplexity in relation to the impact that these systems have in the world of productivity, and then ultimately their social impact, has be witnessed in recent years. Future robotics represent a tremendous challenge in the field of mathematics because of the central role their control plays in the context of this field. In fact, robot control is one of the most important and challenging topics for mathematicians, engineers, physicians, and practitioners. Mathematical issues are the kernel of the design of control of movements and performance of robots. This Special Issue aims to collect the latest advancements of mathematical methods for solving not only theoretical but also applied problems of classical and also modern robot structures, such as robotic manipulators, walking robots, flexible robots, haptic robots, and any kind of old and new mechanisms with all possible tasks, in grasp, manipulation, and motion for any kind of their possible issues and applications. Advances in robot control, tackling theoretical complexity as well as practical applications, have been given a considerable boost by the use of mathematical methodologies. The Special Issue titled "Mathematics in Robot Control for Theoretical and Applied Problems" where researchers share their discoveries summarizes the latest results of the application of mathematical insights in robotic field.

2. Presentation of the Research Papers

Trajectory tracking control of a solar tracking system is tackled by means of an adaptive active disturbance rejection control scheme as shown in Contribution 1. The state and disturbance estimation system is based on the combination of a time varying identification system and an adaptive observer.

To facilitate robotic problem-solving, especially in industrial settings, the authors of Contribution 2 develop a predicate-based logical paradigm. In addition to improving automation processes, this model also aids in the study of applications designed for problem-solving and intelligent agent-based manufacturing systems.

Using homomorphic encryption, in Contribution 3 authors discuss safe computing and control in robots. The ramifications of their approach to improving robot control system security are substantial, especially in settings where access to critical data is restricted.

For hyper-redundant robots, Contribution 4 provides a methodical manual for kinematic modeling. The evolution of hyper-redundant robot design and control is aided by this contribution's assistance in modeling these complex robots.

A Robust distance and orientation synchronization for differential-drive mobile robots is a topic explored in Contribution 5. As a result, the control accuracy and performance of mobile robotic systems may be greatly enhanced by using the proposed active disturbance rejection control technique.

To mitigate the effects of inaccurate distance estimations, the authors of Contribution 6 describe a cooperative control method for vehicle platoons. Their method improves the stability and dependability of platoon control systems, leading to more secure and productive vehicle traffic flow.

In Contribution 7 the authors discuss issues with tracked mobile robots and terrain navigation. To improve trajectory tracking and overall performance in difficult terrains, their kinematic technique incorporates speed adjustment based on pointwise terrain gradients.

In Contribution 8 2D Lidar technology is applied to the problem of improving autonomous navigation within buildings. This approach enhances the usefulness of autonomous mobile robots in confined locations by increasing the precision with which maps are constructed and routes are planned.

In their investigation into automation and construction, the authors of Contribution 9, as highlighted in references, place a significant emphasis on process control, monitoring, and diagnostics. Their focus revolves around the application of these principles in the context of concrete 3D printing. The study's findings shed light on the effective integration of mathematical techniques to improve robotic applications within the construction sector.

Contribution 10 deals with the lack of data in computer vision and offers a context replacement technique. The method illustrated in the contribution makes it possible for robotic systems to outsource calculations and control safely by making use of homomorphic encryption. This work offers crucial guidance for protecting robot control systems, especially in low-information environments.

A new method for regulating four-bar mechanisms with varied input velocities is presented in Contribution 11. The authors' approach is dynamic, allowing for fine-grained control over the movements that are produced. This development expands robotic systems' applicability and thereby increases their adaptability. All these aspects are very well analyzed.

The authors of Contribution 12 discuss how robotic telescopes can more reliably identify the sky. The quality of astronomical observations is enhanced as a result of their use of mathematical approaches to improve the navigation process. This work makes a major improvement to astronomical research by enhancing the automated telescopes' ability to navigate their surroundings.

The problem of centralized control of coverage in multi-quadrotor systems is investigated in Contribution 13. The authors provide a strategy for achieving finite-time convergence by adapting the goal function to meet consensus requirements. With this novel method, multi-quadrotor systems may function in a wide variety of network architectures without sacrificing economy or performance.

3. Conclusions

In summary, the Special Issue "Mathematics in Robot Control for Theoretical and Applied Problems" has presented a wide variety of research papers that together highlight the central importance of mathematics in defining the subject of robot control. Multi-quadrotor systems, telescopes, manipulators, computer vision, navigation, and building are only some of the areas covered in these publications. These works show how mathematics may be used to solve difficult problems and propel progress in our theoretical knowledge and practical use of robotic systems.

Conflicts of Interest: The authors declare no conflicts of interest.

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