CAMBRIDGE
UNIVERSITY PRESS

EDITORIAL

Editorial to the special issue on "Modeling and control of innovative robots"

1. Introduction

The core of this special issue is a collection of extended versions of paper that were contributed to International Conference on Robotics in Alpe-Adria-Danube Region (RAAD) 2022. For three decades, the RAAD conference has been a platform for the presentation of latest research results and a venue for discussion and exchange of ideas. The first event in this series was organized in 1991 in Portorož, Slovenia, by the Jožef Stefan Institute as the 1st International Meeting on Robotics in Alpe Adria Region. In the following years, its name was changed to International Workshop on Robotics in Alpe-Adria Region (RAA) until 1996, when it became the International Conference on Robotics in Alpe-Adria-Danube Region (RAAD). The 31st RAAD 2022 was, therefore, a special event celebrating the continuous success of the conference and the vitality of the scientific community in the Alpe-Adria-Danube Region, and it was an honor to have the founder of RAAD, Jadran Lenarčič from the Jožef Stefan Institute, Ljubljana, Slovenia, giving a welcome address. The conference was held on June 8–10, 2022 in Klagenfurt am Wörthersee, Austria. It brought together robotics researchers in academy and industry from 29 countries, mainly in the Alpe-Adria-Danube Region, but also from other countries worldwide.

2. Special issue summary

After a thorough review process, 10 papers presented at the RAAD conference were selected for inclusion in this issue.

The paper "Projecting Robot Dynamics onto Trajectories" [1] deals with the time-optimal motion planning along a prescribed path by projecting the dynamics of a robot manipulator onto the path to be executed. In "Time-optimal path following for non-redundant serial manipulators using an adaptive path-discretization" [2], an adaptive sampling method for solving the time-optimal path following problem is presented, which ensures continuity of the solution. The time-optimal motion planning of wheeled inverted pendulum (also known as Segway-type systems) is addressed in the paper "Multistage approach for trajectory optimization for a wheeled inverted pendulum passing under an obstacle" [3], where a method for finding an initial guess for the optimization problem is presented. In "Exploration-Exploitation-Based Trajectory Tracking of Mobile Robots Using Gaussian Processes and Model Predictive Control" [4], an iterative learning-based procedure for the trajectory tracking of mobile robots is propoed.

Departing from the concept of fractional order control, in "Fractional Order Inspired Weighted Sum PD-type Feedback in Fixed Point Iteration-based Adaptive Control" [5], a control scheme is proposed that has similar properties as fractional order controllers but a simpler structure. The control of a quadrotor UAV is addressed in "Barrier Lyapunov function and adaptive backstepping-based control of a quadrotor UAV" [6] using barrier Lyapunov functions to account for the constraint satisfaction. A bio-inspired single-track mobile robot is reported in the paper "Porcospino, Spined Single-Track Mobile Robot for Inspection of Narrow Spaces" [7]. A mobile robot for agriculture application is described in "Decoupled motion planning of a mobile manipulator for precision agriculture" [8]. The paper "Contact force regulation in physical human-machine interaction based on model predictive control" [9] introduces the use of a Model Predictive Controller for controlling the force impulse on a human subject.

In "Precise positioning in a robotized laser-cutting machine allowed by a three-V-shaped-groove kinematic coupling" [10], a model for a laser cutting machine with a special kinematics is reported, to calculate positioning errors caused by the mechanical structure's elastic deformation.

In addition to these RAAD papers, the paper "Modeling and invariably horizontal control for the parallel mobile rescue robot based on PSO-CPG algorithm" [11] reports on the modeling and control of a walking robot based on a parallel kinematics.

3. Conclusion

Innovation in robotics has a long tradition in the Alpe-Adria-Danube Region. This is clearly reflected by the papers included in this special issue. Novel control concepts clearly represent a major research topic, beside innovative designs for novel applications. We are confident that the reader will find these papers interesting and inspiring.

References

[1] F. Pfeiffer, "Projecting robot dynamics onto trajectories," *Robotica* **41**(7), 2122–2138 (2023). doi: 10.1017/S026357472300036X.

[2] T. Marauli, H. Gattringer and A. Müller, "Time-optimal path following for non-redundant serial manipulators using an adaptive path-discretization," *Robotica* **41**(6), 1856–1871 (2023). doi: 10.1017/S026357472300022X.

[3] C. Zauner, H. Gattringer and A. Müller, "Multistage approach for trajectory optimization for a wheeled inverted pendulum passing under an obstacle," *Robotica* **41**(8), 2298–2313 (2023). doi: 10.1017/S0263574723000401.

[4] H. Eschmann, H. Ebel and P. Eberhard, "Exploration-exploitation-based trajectory tracking of mobile robots using Gaussian processes and model predictive control," *Robotica* **41**(10), 3040–3058 (2023). doi: 10.1017/S0263574723000863.

[5] B. Varga, J. K. Tar and R. Horváth, "Fractional order inspired iterative adaptive control," *Robotica* **42**(2), 482–509 (2024). doi: 10.1017/S0263574723001595.

[6] A. Khadhraoui, A. Zouaoui and M. Saad, "Barrier Lyapunov function and adaptive backstepping-based control of a quadrotor UAV," *Robotica* **41**(10), 2941–2963 (2023). doi: 10.1017/S0263574723000735.

[7] S. E. Nodehi, L. Bruzzone and P. Fanghella, "Porcospino, spined single-track mobile robot for inspection of narrow spaces," *Robotica* **41**(11), 3446–3462 (2023). doi: 10.1017/S0263574723001108.

[8] G. Colucci, L. Tagliavini, A. Botta, L. Baglieri and G. Quaglia, "Decoupled motion planning of a mobile manipulator for precision agriculture," *Robotica* **41**(6), 1872–1887 (2023). doi: 10.1017/S0263574723000243.

[9] D. P. Quiñones, M. Paterna, C. De Benedictis, D. Maffiodo, W. Franco and C. Ferraresi, "Contact force regulation in physical human-machine interaction based on model predictive control," *Robotica* **41**(11), 3409–3425 (2023). doi: 10.1017/S0263574723001066.

[10] C. De Benedictis and C. Ferraresi, "Precise positioning in a robotized laser-cutting machine allowed by a three-V-shaped-groove kinematic coupling: A feasibility study," *Robotica* **41**(9), 2703–2712 (2023). doi: 10.1017/S0263574723000619.

[11] W. Chen, H. Cheng, W. Zhang, H. Wu, X. Liu and Y. Men, "Modeling and invariably horizontal control for the parallel mobile rescue robot based on PSO-CPG algorithm," *Robotica* **41**(11), 3501–3523 (2023). doi: 10.1017/S0263574723001133.

Andreas Müller
Institute of Robotics, Johannes Kepler Universitat Linz,
Linz, Austria

Mathias Brandstötter
ADMiRE Research Center, Carinthia University of Applied Sciences,
Villach, Austria

Lotfi Romdhane
American University of Sharjah, Sharjah, United Arab Emirates

Alessandro Gasparetto
Dipartimento Politecnico di Ingegneria e Architettura,
Università degli Studi di Udine, Udine, Italy