Simone Pirrera's Curriculum Vitae

Name and Surname: Simone Pirrera.
Date of birth: 11/11/1997.
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Qualifications:
Ph.D. in Computer and Control Engineering. Politecnico di Torino. 16/05/2025.

Ph.D. schools:

- EECI International Graduate School on Control. May 2025. "M12 - An overview on Observer Design Methods for Nonlinear Systems" module. 21 hours, Barcelona (Spain).
- Nonlinear System Identification. 30 hours. June 2022. Leuven (Belgium).
- Deep Learning for System Identification. 30 hours. June 2024. Lugano (Switzerland).
- EECI International Graduate School on Control. June 2023. "M18 - Learning to control" module. 21 hours, London (UK).

Master's degree in Mechatronic Engineering (LM-25). Politecnico di Torino. 27/07/2021. Score 110/110 *cum laude.*

Bachelor's degree in Electronic Engineering (L-8). Politecnico di Torino. 26/07/2019. Score 109/110.

Professional experience:
Postdoctoral Research Fellow (Politecnico di Torino). Jan 2025 – Jun 2026.
Ph.D. student (Politecnico di Torino). Nov 2022 – May 2025.

Awards.
I was awarded the *"Best poster presenter award"* at the DAUIN Ph.D. poster day event organized by the Department of Computer and control engineering at Politecnico di Torino.

Summary of research expertise:
My research lies at the intersection of the **control theory, mathematical optimization, and data-driven design** fields. The focus of the research is developing theoretically grounded algorithms that enable reliable and efficient control of complex dynamical systems: the use of control-theoretic principles is adopted to design optimization algorithms and data-driven controllers with provable guarantees.

A first research line concerns **and set-membership methods for identification and data-driven control design**. I contributed methods for continuous-time system identification and extended them to MIMO systems with improved computational efficiency. Also, I contributed to the direct data-driven controller design problem, showing how robust stability guarantees can be obtained under bounded measurement noise conditions.

Another research line focused on the development of a **feedback-control framework for equality-constrained optimization**, where Lagrange multipliers are regulated through dynamic feedback controllers. This approach provides a novel perspective that bridges continuous-time control dynamics and optimization algorithms. Also, I extended the approach to classes of **inequality-constrained** and **non-differentiable** problems, laying the groundwork for more general optimization frameworks.
The developed optimization algorithms naturally find applications in the development of methods for **system identification and efficient optimal controller design.** By building on the proposed optimization framework, my work focused on the introduction of a novel approach to system identification that avoids the numerical vanishing and exploding gradient issues by formulating constrained optimization problems. Concerning optimal controller design, my research has recently expanded toward **fast and hardware-efficient model predictive control (MPC)**. I introduced single-iteration MPC schemes and proposed analog circuit implementations of MPC to achieve ultra-fast control in embedded systems. These efforts aim to make advanced optimal control methods viable in high-speed and resource-constrained environments. The developed **fast MPC** algorithms have been applied to relevant control problems in the **energy and power systems**. Specifically, I focused on the control of DC-DC converters in power electronics systems and the wave energy systems.

Role during visit.

During the visit, my role will be to advance a research line on **wave energy conversion systems** by building an end-to-end framework that connects data-driven modelling, optimization-based control, and real-time implementation. The activity will build directly on my recent works on model predictive control and constrained optimization, extending these ideas to the modelling and control of wave energy devices.

The first objective of the visit will be the **data-driven modelling of the wave energy converter** within a Koopman-operator framework. Under the guidance of Prof. Hugh Wolgamot, I will deepen my understanding of the underlying hydrodynamic effects governing the device behaviour. Combining this with my background in set-membership identification and uncertainty-aware modelling, I will develop identification procedures capable of extracting a reliable and interpretable dynamic model from experimental and simulated data.

Based on the identified model, I will design an **efficient model predictive control (MPC) strategy** tailored for real-time energy maximization and constraint handling. Building upon my contributions to fast optimization algorithms and MPC schemes, the goal is to obtain controllers that retain optimality and safety properties while drastically reducing computational burden, enabling deployment on embedded platforms.

A further key role will be the **translation of the control strategy into hardware-ready solutions**. Drawing on my work on analog MPC implementation, I will explore efficient embedded and hardware-oriented realizations of the controller, ensuring low latency and energy-efficient operation. To maximize impact and reproducibility, I will **develop open-source software tools** implementing the identification and control design algorithms, promoting transparency and facilitating adoption by the research community and industry.

Finally, I will contribute to **experimental validation activities**, supporting system integration and testing to assess performance improvements in realistic operating conditions. This will provide critical insight into robustness, energy capture efficiency, and real-time feasibility.

Competitive grant funding.

The visit will take place as the outgoing phase of the **Marie Skłodowska-Curie Actions (MSCA) postdoctoral fellowship** I was awarded. This MSCA project is part of the Europe HORIZON programme, 2025 call. The project **"Smart Wave Energy conversion via Learning and Low-cost control" (SWELL)**, is assigned project number 101276493 and the grant agreement is currently under preparation. The total founding assigned to this project is about **332K euros** and has a total duration of 36 months: 24 of which at UWA and 12 at the host institution (Politecnico di Torino).

Publications.

Since 2022, when I started my Ph.D., I co-authored 10 publications: 8 journals and 7 conference proceedings in the field of systems and control. These received a total of 50 citations, and my h-index is 4.

Below, a list of the most significant publications in the last five years (corresponding to the whole career):

Journals.

J1) V. Cerone, S. M. Fosson, **S. Pirrera**, A. Re, D. Regruto, "Feedback control of Lagrange multipliers for non-smooth constrained optimization", Under review in *IEEE Transactions on Automatic Control.* Submitted version available at doi:10.48550/arXiv.2604.06511.

J2) V. Cerone, S. M. Fosson, **S. Pirrera**, D. Regruto, "A constrained optimization approach to nonlinear system identification through simulation error minimization", Under review in *Automatica.* Submitted version available at doi:10.48550/arXiv.2509.01461.

J3) **S. Pirrera**, L. Calogero, F. Gabriele, D. Regruto, A. Rizzo, G. Setti, "A Fully Analog Implementation of Model Predictive Control with Application to Buck Converters", Under review (second round) in *IEEE Transactions on Control System Technology.* Submitted version available at *ArXiv.* doi:10.48550/arXiv.2509.05463.

J4) V. Cerone, S. M. Fosson, **S. Pirrera**, D. Regruto, "Set-membership identification of continuous-time MIMO systems via Tustin discretization", Under review (second round) in *Automatica*. Submitted version available at doi:10.48550/arXiv.2508.19348.

J5) **S. Pirrera**, F. Ripa, D. Astolfi, V. Cerone, S. M. Fosson, D. Regruto, "Global Convergence of Control-Based Lagrangian Flows for Non-Convex Optimization", in *IEEE Control Systems Letters*, to be published, 2026. Submitted version available at doi:10.48550/arXiv.2605.22486.

J6) **S. Pirrera**, F. Gabriele, D. Lena, F. Pareschi, D. Regruto, G. Setti, "Robust Load Disturbance Rejection in PWM DC-DC Buck Converters", in *IEEE Transactions on Control System Technology,* to be published, 2026. doi:10.1109/TCST.2026.3701112.

J7) V. Cerone, S. M. Fosson, **S. Pirrera,** D. Regruto, "A new framework for constrained optimization via feedback control of Lagrange multipliers," in *IEEE Transactions on Automatic Control*, vol 70, pp. 7141-7156, 2025. doi:10.1109/TAC.2025.3568651.

J8) M. Abuabiah, V. Cerone, **S. Pirrera,** D. Regruto, "A Non-Iterative Approach to Direct Data-Driven Control Design of MIMO LTI Systems," in *IEEE Access*, vol. 11, pp. 121671-121687, 2023. doi:10.1109/ACCESS.2023.3329070.

Conferences.

C1) **S. Pirrera**, N. Faedo, S. M. Fosson, D. Regruto, "Real-Time Single-Iteration Model Predictive Control for Wave Energy Converters", 23rd International Federation of Automatic Control (IFAC) *World Congress*, August 23-28, 2026, to be published. Submitted version available at doi:10.48550/arXiv.2509.05853.

C2) V. Cerone, S. M. Fosson, **S. Pirrera,** D. Regruto, "A feedback control approach to convex optimization with inequality constraints," 2024 IEEE *63rd Conference on Decision and Control* (CDC), Milan, Italy, 2024. pp. 2538-2543, doi:10.1109/CDC56724.2024.10885825.

C3) V. Cerone, S. M. Fosson, **S. Pirrera**, D. Regruto, "Set-membership identification of continuous-time systems through model transformation," IEEE *61st Conference on Decision and Control* (CDC), Cancun, Mexico, 2022. pp. 868-873, doi:10.1109/CDC51059.2022.9992815.

Scientific events.

I was invited presenter at the

- Tutorial Session con "Control-Theoretic Analysis and Design of Optimization Algorithms", European Control Conference (ECC), June 24-27, 2025. Organized by D. Regruto and S. M. Fosson.

Currently, I am involved in the organization of:

- Open invited track on "*Modelling and control of marine offshore structures*" at the 2026 International Federation of Automatic Control (IFAC) World Congress. August 23-28, 2026, Busan, Republic of Korea. Co-organized with N. Faedo, J. Ringwood, M. E. Benbouzid, D. Regruto, P. Puleston, E. Pasta, and F. Mosquera.