

Curriculum vitae di *Marco Bolignari*

Sottosettore ERC primario: **PE7_4** systems engineering

Sottosettori ERC secondari: **PE7_10** Robotics, **PE8_7** Mechanical Engineering

PERSONAL DETAILS

Family name, First name: Bolignari Marco

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• **Education and key qualifications**

- 04/2022 **PhD in Materials, Mechatronics and Systems Engineering, *cum laude***
Department of Industrial Engineering (DII), University of Trento, Italy
PhD Supervisor: Prof. [Marco Fontana](#)
Topic: Rolling-diaphragm hydrostatic transmission for the remote actuation of high-performance robots.
Description: my PhD research aimed at developing a novel design approach to robot actuation by means of Rolling Diaphragm Hydrostatic Transmissions. I designed, manufactured, and experimentally characterized several prototypes, laying the foundation for a new generation of robotic arms, merging collaborative and industrial requirements in a unified, advanced technological paradigm.
Award: Best PhD Student of Department of Industrial Engineering of University of Trento (reference [here](#))
- 07/2022 **Qualification to the profession of Industrial Engineer**
University of Padua, Italy
- 03/2018 **Master's degree in Mechatronic Engineering (LM-33), *cum laude***
Department of Industrial Engineering (DII), University of Trento, Italy
Topic: Design and experimental characterization of a hydrostatic transmission for rehabilitation exoskeletons.
- 11/2014 **Bachelor's Degree at Mechanical Engineering**
Department of Mechanical Engineering, University of Florence, Italy.
Topic: Dynamic simulation and analysis of various wheel-rail contact models.

• **Current position**

- 2024 – today **CEO & Co-founder**
[Fluid Wire Robotics s.r.l.](#)
Description: At FWR, we pursue designing robotics solutions for harsh environments to accomplish harmful activities in dangerous or remote locations and keep humans out of harm's way. Tough and rugged robots are the key to enabling unprecedented scenarios in manufacturing, subsea and space industries, enhancing safety, reliability, and efficiency.
Background: The “Fluid Wire” technology was originally developed during my PhD, primarily for human–robot interaction and rehabilitation applications. Through an independent technology transfer process, I assembled a startup-oriented team and validated the market potential of the technology. This led to a strategic pivot toward harsh environments, enabling significantly more demanding applications and unlocking capabilities that were not fully expressed in the initial research phase. Colleagues, technicians, and supervisors who supported this journey are now co-founders.
VC Funding: €1.4M raised to date

Awards/Achievements: Despite being early-stage and pre-commercial, Fluid Wire Robotics was selected among 74 startups worldwide (out of 2,600+ applicants) for **DIANA**, NATO's accelerator program for dual-use technologies. The company is also part of the **ESA BIC Turin** incubator (backed by the European Space Agency) and has received **ESA Spark Funding**. Most recently, FWR was awarded a €2.5M **EIC Accelerator** grant, with the potential for over €3M in additional equity investment, positioning the company as an emerging European player in the space robotics sector.

- **Previous positions**

2022 – 2024 **Post-doc researcher**

Institute of Mechanical Intelligence (IIM), Scuola Superiore Sant'Anna, Pisa, Italy

Topic: Development of a low-cost Electro-Hydrostatic Exoskeleton for upper-limb rehabilitation

2021-2022 **Visiting Researcher**

Dynamic Locomotion Group, Max Planck Institute for Intelligent Systems (MPI-IS), Stuttgart, Germany

Supervisor: [Alexander Badri-Sprowitz](#)

Topic: Diaphragm ankle actuation for efficient series elastic legged robot hopping

Description: I proposed investigating the application of the results of my PhD research to legged robots. Alexander Badri-Sprowitz, group leader of the Dynamic Locomotion Group @ MPI-IS, accepted my proposal and we started a collaboration aimed at developing the first robotic leg actuated by Rolling Diaphragm Transmissions, specifically designed to provide energy-efficient series-elastic response.

Results: The collaboration resulted in the construction of a remarkable experimental [prototype](#). Research results were published in a conference paper (IROS2022, Kyoto).

RESEARCH ACHIEVEMENTS AND PEER RECOGNITION

TECHNOLOGY TRANSFER CONTRIBUTION

In parallel with the final years of my academic path—outlined below and focused on the study of hydrostatic transmissions (RDHT) for collaborative applications and the development of rehabilitation robots—I began a technology transfer journey driven by the need to bring my research into real-world applications and generate a direct impact on society.

This technology transfer process started with market validation of the technology, including the analysis of needs and the application landscape of robotics in today's markets. Through this process, I revisited the assumptions that had originally guided my research and, together with the team that was gradually forming around the initiative, we recognized that the technology developed during my PhD could address needs that are both more current and significantly more challenging than those initially considered.

This led to the founding of Fluid Wire Robotics in June 2024. Building on the hydrostatic technology developed during my PhD research, the company is now developing a new generation of robots capable of delivering advanced manipulation capabilities in extreme environments in a versatile, simple, and scalable way. The short-term focus on terrestrial sectors (nuclear applications, outdoor environments, ATEX, and high-temperature settings) is part of a longer-term strategy that positions Fluid Wire Technology as an enabling solution for the space sector, particularly within the emerging In-Orbit Servicing market.

This experience is enriching me across multiple fronts, leading me to present at major conferences, define intellectual property protection strategies, engage with decision-makers from leading international companies in relevant sectors, and develop commercial strategies and financial models to support the growth of an emerging hardware-based technology venture.

During its first two years, the company has established a distinctive positioning across technological, commercial, and funding dimensions, described below.

- **Technology:** increase of the TRL from 3, achieved during my PhD and in the pre-company phase, to 5.
 - The transition from **TRL 3 to 4** was achieved through the development of a 4-DoF laboratory robotic arm for comprehensive validation of performance and potential use cases.
 - The subsequent advancement from **TRL 4 to 5** was achieved by experimentally validating the technology in relevant environments, including testing in radioactive conditions, thermal-vacuum chambers, high-temperature climatic chambers, and underwater.
 - The next challenge in scaling the TRL lies in testing prototypes in operational environments at early adopter sites, industrializing the product, and ensuring compliance with relevant regulations.
- **Market:** Fluid Wire Robotics is consolidating its identity and market positioning through a range of initiatives, both private and institutional.

2026 – 2028	EIC Accelerator <u>Challenge:</u> Innovative in-space servicing, operations, robotics and technologies for resilient EU space infrastructure. <u>Project:</u> DANTE – Dexterous Arm for Non-Terrestrial Environments. <u>Funding:</u> €2.500.000 grant + equity investment under negotiation. <u>Description:</u> This project aims to advance Fluid Wire Technology to space-grade standards, enabling a new generation of advanced, scalable, and reliable robotic arms for the expansion and industrialization of the in-orbit servicing market. The ultimate milestone of the project is the achievement of an In-Orbit Demonstration (IOD). <u>Reference:</u> Link
2025 – today	Co-development with Leonardo <u>Challenge:</u> Solvers Wanted – New perspectives for space inspection. <u>Project:</u> Towards a New Generation of Advanced Space Robotic Arms with Remote Actuation via Fluid-Wire Transmissions. <u>Funding:</u> NDA <u>Description:</u> Within the framework of Leonardo’s open innovation program Solvers Wanted, Fluid Wire Robotics has been awarded a co-development contract in collaboration with Leonardo’s Space Division. This is a multi-year program, starting with a feasibility study aimed at benchmarking the performance of Fluid Wire Technology against current space solutions, as well as assessing its compatibility and response in relevant environmental conditions. The overarching objective of the program is to position Fluid Wire Robotics as a commercial supplier of space manipulation systems for Leonardo within the next five years. <u>Reference:</u> Link
2025 – 2026	ESA Spark Funding <u>Project:</u> SWIR – Space WithIn Reach. <u>Funding:</u> €75.000 <u>Description:</u> This program is focused on technology transfer, either upstream or downstream. In our case, we are addressing an upstream transfer by adapting a technology that is already established in terrestrial applications to the space sector. The objective of this project is to demonstrate the feasibility of deploying Fluid Wire actuation technology, while ensuring compliance with existing standards, to develop typical interfaces and gripping systems used in the in-orbit servicing domain, which are still largely based on conventional actuation technologies. <u>Reference:</u> Link
2025	DIANA <u>Challenge:</u> Critical Infrastructure & Logistics <u>Project:</u> Next-Gen Harsh-Environment-Proof Robotic Arm <u>Funding:</u> €100.000 <u>Description:</u> DIANA (Defence Innovation Accelerator for the North Atlantic),

backed by NATO, selected Fluid Wire Robotics for its 2025 cohort as one of 74 startups chosen from over 2,600 applicants worldwide. The company was accelerated by DualTech at Plug & Play. During this six-month program, Fluid Wire Robotics explored how the versatility of its technology can accelerate the adoption of autonomous robotic systems by defence operators.

Reference: [Link](#)

2024 – 2026

ESA-BIC Turin

Topic: incubation program

Funding: **€50.000**

Description: This program represents Fluid Wire Robotics' first step toward entering the space market, providing initial validation of its commercial proposition and a preliminary demonstration of Fluid Wire technology in a thermal vacuum chamber to emulate operation in a space environment. The ultimate objectives of the program are to achieve TRL 5 for space applications, secure a contract (either with a private or institutional space operator) and establish a dedicated space division within Fluid Wire Robotics.

Reference: [Link](#)

- **Funding:** To support rapid growth aligned with the development timelines of strategic markets, Fluid Wire Robotics has successfully secured venture capital funding. To date, **€1.400.000** has been raised, and a new international investment round is currently under negotiation.
- **Patent Inventor**

02/2022	(102022000002075) System for Remote Actuation of Articulated Mechanisms
08/2023	(102023000016416) Remote Actuation System
11/2023	(102023000025191) Low-Friction Bidirectional Fluidic Actuation System

ACADEMIC RESEARCH

My academic work spanned the period 2018-2023. I'm now focusing on Fluid Wire Robotics' tech-transfer, without ruling out a return to academic research in the future.

A brief overview of my academic contributions is provided below.

The capability of safely operating in crowded, unstructured, anthropic environments led to a rapid spread of force-controllable collaborative robotic arms. However, the conflicting requirements posed by the traditional industrial applications in terms of operating speed and desired impedance still represent an unsolved trade-off. Rolling Diaphragm Hydrostatic Transmissions (RDHTs) are an ideal technology to merge collaborative and industrial robots in a unified advanced technological paradigm. Shaping a suitable open-loop response, regardless the applied control, by embedding requirements of safety and performance in smart mechanical structures is the key principle that drove this study: lightweight design and backdrivability are considered as the ultimate approach to the design of the next generation of human-like robotic arms. RDHTs are simple, passive systems that reflect torques across long distances in the form of fluid pressure and enable the remote positioning of electric motors, whose mass is taken away from the robot. Remotely located low-inertia direct or quasi-direct drive actuators, transparent and stiff torque transmission of the motors' action to the joints, and lightweight links are the main ingredients to create safe robots with low mechanical impedance, high specific power, excellent backdrivability and large force bandwidth.

In my research (from 2018 to 2023) I've widely studied the dynamics behind RDHTs and investigated different configurations and applications, i.e. rehabilitation robots, humanoids and legged robots.

I designed and manufactured a modular robotic joint based on novel hydraulic cylinders; the cylinders implement rolling diaphragms and feature a minimally constrained floating-bonnet architecture that enables zero-leakage, low-friction operation. The joint generates a maximum rated torque of 25 Nm and exhibits a static friction value of just 0.24 Nm (0.96% of the maximum rated torque). Moreover joint's frictional properties are independent of the applied load, which is a favorable feature inaccessible to the widely-used cable-based transmission systems. I explored the use of a low-cost pressure sensing technique in combination with a Smith-predictor-based joint torque control to achieve enhanced torque setpoint regulation and high-

quality physical Human-Robot Interaction (pHMI). Experimental tests showed a reduction in backdriving torque of 67% and in settling time of 95% with respect to the open loop. Then I extended the mechanical and control architecture to a robotic arm. Excellent force controllability was confirmed in collaborative manipulation tasks that involve the displacement of a heavy payload and pHMI. The novel layout of the rolling diaphragm cylinders was further challenged by developing a miniaturized pneumatic version of the transmission system with intrinsic series-elastic properties for the remote actuation of the ankle joint of an agile hopping robotic leg. Finally, an effective solution for implementing programmable physical damping in hydrostatic transmissions is conceived.

- **Bibliometric indices (as of 14/03/2025)**

	Personal page	Publication Number	Citations	H-index
Scopus	Link	7	97	5
Google Scholar	Link	10	136	6

- **Selected Publications**

- 07/2023 **Hydrostatic Transmissions for Lightweight Human-Friendly Robotic Arms**
Authors: Bolignari, Marco, Gianluca Rizzello, Luca Zaccarian, Marco Fontana.
Journal: IEEE Transaction on Robotics
[DOI: 10.1109/TRO.2023.3290310](#)
- 10/2022 **Diaphragm Ankle Actuation for Efficient Series Elastic Legged Robot Hopping**
Authors: Marco Bolignari, An Mo, Marco Fontana, Alexander Badri-Spröwitz.
Conference: 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
[DOI: 10.1109/IROS47612.2022.9981060](#)
- 04/2021 **Smith-Predictor-Based Torque Control of a Rolling Diaphragm Hydrostatic Transmission**
Authors: Bolignari, Marco, Gianluca Rizzello, Luca Zaccarian, Marco Fontana.
Journal: IEEE Robotics and Automation Letters, vol. 6, no. 2, pp. 2970-2977, April 2021
[DOI: 10.1109/LRA.2021.3062310](#)
- 03/2021 **Electrostatic bellow muscle actuators and energy harvesters that stack up**
Authors: I. D. Sirbu, G. Moretti, G. Bortolotti, M. Bolignari, S. Diré, L. Fambri, R. Vertechy, M. Fontana
Journal: Science Robotics, vol. 6, February 2021
[DOI: 10.1126/SCIROBOTICS.AAZ5796](#)
- 03/2020 **Design and Experimental Characterization of High-Performance Hydrostatic Transmission for Robot Actuation**
Authors: Bolignari, Marco, Marco Fontana.
Journal: Meccanica 55, 1169–1179
[DOI: 10.1007/s11012-020-01143-z](#)

- **Teaching Activity**

- 04/2019 **Lecturer**
University: University of Trento, Italy
Course: Analysis and Synthesis of feedback systems: quadratic functions and LMIs – 10 hours course as part of the Automatic Control course held by Prof. Luca Zaccarian, University of Trento
Description: I was in charge of frontal teaching activities, including theoretical topics and practical exercises. I also prepared and evaluated part of the final exam of the course.

- **Conference speaker**

- 10/2022 2022 IEEE International Conference on Intelligent Robots and Systems (IROS), Kyoto, Japan
05/2021 2021 IEEE International Conference on Robotics and Automation (ICRA), Xi' An, China
10/2019 I-RIM 3D, Rome, Italy
10/2018 2018 IEEE International Conference on Intelligent Robots and Systems (IROS), Madrid, Spain

- **Conference chair**

- 10/2022 2022 IEEE International Conference on Intelligent Robots and Systems (IROS), Kyoto, Japan
Session: Biologically-Inspired Robots 3