Alessio Caporali

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Biographical Sketch

Junior Assistant Professor (RTD-A) at the University of Bologna since 2024, working at the intersection of robotics and machine learning. Its research focuses on the perception and manipulation of deformable objects, aiming to advance the capabilities of robotic systems in handling complex objects. Its primary research interests include computer vision and tactile sensing, which involve developing algorithms to enhance a robot's understanding of target objects and their environment; robotic manipulation, particularly addressing tasks such as grasping, sliding, and motion planning; deformable object modeling, to predict and control their behavior; and deep learning for physical systems, leveraging neural network approximations of dynamical systems to facilitate robotic tasks.

Education and Training

Apr. 2024 — **PhD** in Biomedical, Electrical and Systems Engineering at the University of Bologna. Thesis title: "*Robotic Perception and Manipulation of Deformable Linear Objects*". Supervisor: Prof. Gianluca Palli. Co-Supervisor: Prof. Claudio Melchiorri.

Dec. 2019 — **Master's Degree** in Automation Engineering at the University of Bologna.Thesis title: "*Robotic Manipulation of Cloth-like Deformable Objects*". Supervisor: Prof. Gianluca Palli.

Oct. 2017 — **Bachelor's Degree** in Automation Engineering at the University of Bologna.Thesis title: "*Ros-Based Control of a Kuka Youbot Arm*". Supervisor: Prof. Claudio Melchiorri. Co-Supervisor: Prof. Gianluca Palli.

2015-2016 — International Exchange Student for one academic year within the Almatong project at Tongji University, Shanghai (China).

Professional Employment

Jun. 2024 — **Junior Assistant Professor (RTD-A)** at the University of Bologna, Department of Electrical, Electronic and Information Engineering.

2023-2024 — **Research Fellow (post-doc)** at the University of Bologna, Department of Electrical, Electronic and Information Engineering, for the European project IntelliMan ("AI-Powered Manipulation System for Advanced Robotic Service, Manufacturing and Prosthetics", GA no. 101070136, www.intelliman-project.eu).

2019-2020 — **Research Fellow** at the University of Bologna, Department of Electrical, Electronic and Information Engineering, for the European project REMODEL (Robotic tEchnologies for the Manipulation of cOmplex DeformablE Linear objects", GA no. 870133, www.remodel-project.eu).

Teaching

2024-2025 **Professor** of the academic course *"97985 - Laboratorio di Informatica e Automazione"* (Laboratory of Informatics and Automation), BSc in Mechatronics, University of Bologna. 6 CFU/60 hours.

2024-2025 **Professor** of the academic course *"92996 - Autonomous and Mobile Robotics M (Modulo 2)"*, MSc in Automation Engineering, University of Bologna. 6 CFU/60 hours.

2023-2024 **Adjunct Professor** of the academic course *"97985 - Laboratorio di Informatica e Automazione (Modulo 2)"* (Laboratory of Informatics and Automation), BSc in Mechatronics, University of Bologna. 6 CFU/60 hours.

2023-2024 **Adjunct Professor** of the academic course *"B0839 - Laboratorio di Informatica e Automazione (Modulo 3)"* (Laboratory of Informatics and Automation), BSc in Mechatronics, University of Bologna. 6 CFU/60 hours.

2023-2024 **Tutor** of the academic course *"87269 - Automation Software and Design Patterns M"* (Prof. Gianluca Palli), MSc in Automation Engineering, University of Bologna. 6 CFU/60 hours.

2022-2023 **Tutor** of the academic course *"87269 - Automation Software and Design Patterns M"* (Prof. Gianluca Palli), MSc in Automation Engineering, University of Bologna. 6 CFU/60 hours.

2021-2022 **Tutor** of the academic course *"87269 - Automation Software and Design Patterns M"* (Prof. Gianluca Palli), MSc in Automation Engineering, University of Bologna. 6 CFU/60 hours.

2020-2021 **Tutor** of the academic course *"87269 - Automation Software and Design Patterns M"* (Prof. Gianluca Palli), MSc in Automation Engineering, University of Bologna. 6 CFU/60 hours.

Research Projects

2023-ongoing Participation as the person responsible for the activities of *WP5 (Grasping, manipulation and arm-hand coordination)* for the University of Bologna unit in the **IntelliMan project** (AI-Powered Manipulation System for Advanced Robotic Service, Manufacturing, and Prosthetics) coordinated by Prof. Gianluca Palli, funded by the European Commission under the Horizon Europe program;

2020-2023 Participation as the person responsible for the activities of *WP4 (Vision-based Perception)* and *WP5 (Cable Manipulation Planning, Execution and Interactive Perception)* for the University of Bologna unit in the **REMODEL project** (Robotic technologies for the manipulation of complex deformable linear objects) coordinated by Prof. Gianluca Palli, funded by the European Commission under the Horizon 2020 program;

Research Grants

2023 **Research Fellow (Post-doc)** at the University of Bologna, for the European project "IntelliMan" (AI-Powered Manipulation System for Advanced Robotic Service, Manufacturing, and Prosthetics) funded by the Horizon Europe program under the call HORIZON-CL4-2021-DIGITAL-EMERGING-01-11.

2022 **Short Term Research Grant (DAAD)**. Visiting period with the "Robotics and Embedded Systems" group at the Technical University of Munich (Germany).

2022 **Short Term Research Grant (TERRINET)**. Visiting period with the "Robotics and Embedded Systems" group at the Technical University of Munich (Germany).

2020 **Research Fellow** at the University of Bologna, for the European project "REMODEL" (Robotic technologies for the manipulation of complex deformable linear objects) funded by the Horizon 2020 program under the call H2020-NMBP-FOF-2019.

ROSOBECT - University Spin-Off Project

Role Founding Member and Lead Technical Specialist (Sensor Data, AI)

Patent (filed) *"Method for Automatic Recognition, Identification, and Localization of Wired Components Installed in an Electrical Panel"*

Awards Selected for *Call Cobo Power Up* CTECOBO 2024; Finalist for *Best Pitch Cat. Industrial* PNI 2022; First Place *CallForBusinessPlan* UNIBO 2022; Third Place *StartCup Emilia Romagna* ARTER 2022.

Reviewer Activity

Associate Editor

2025 IEEE/RSJ International Conference on Intelligent Robots and Systems
Keywords: Perception for Grasping and Manipulation, Dual Arm Manipulation

Reviewer for International Journals

Reviewer of 17 submissions to IEEE Transactions on Automation Science and Engineering

Reviewer of 17 submissions to IEEE Robotics and Automation Letters

Reviewer of 5 submissions to IEEE Transactions on Mechatronics

Reviewer of 4 submissions to Elsevier Mechatronics

Reviewer for International Conferences

IEEE/RSJ International Conference on Intelligent Robots and Systems

IEEE International Conference on Robotics and Automation

IEEE/ASME International Conference on Advanced Intelligent Mechatronics

IEEE International Conference on Industrial Cyber Physical Systems

Schools and Courses

2023 **SIDRA Summer School**, held by the Italian Automatic Control Research Community.

2022 **SIDRA Summer School**, held by the Italian Automatic Control Research Community.

2022 **Spring School** on Data-driven Model Learning of Dynamic Systems (Ecole Centrale de Lyon, Laboratoire Ampère).

Awards

2024 **Finalist** in the RomeCup 2024 Award competition titled "*Most Promising Researcher in Robotics and Artificial Intelligence*" organized by Fondazione Mondo Digitale ETS and University Campus Bio-Medico of Rome.

2021 **Best Student Paper Award** for the paper: A. Caporali, W. B. Bedada, G. Palli, "A Cyber-Physical System for Clothes Detection, Manipulation and Washing Machine Loading", presented at The 4th IEEE International Conference on Industrial Cyber Physical Systems, 10–12 May, 2021, Victoria, Canada.

Publications

Bibliometrics

Scopus	Citations: 199, h-index: 9
Google Scholar	Citations: 270, h-index: 10

Journal Articles

2024 [1] **Caporali, A.**, Kicki, P., Galassi, K., Zanella, R., Walas, K., Palli, G., "Deformable Linear Objects Manipulation With Online Model Parameters Estimation." In: *IEEE Robotics and Automation Letters* 9.3 (2024), pp. 2598–2605. DOI: 10.1109/LRA.2024.3357310

[2] **Caporali, A.**, Galassi, K., Palli, G., "DLO Perceiver: Grounding Large Language Model for Deformable Linear Objects Perception." In: *IEEE Robotics and Automation Letters* (2024)

2023 [3] Meattini, R., **Caporali, A.**, Bernardini, A., Palli, G., Melchiorri, C., "Self-Supervised Regression of sEMG Signals Combining Non-Negative Matrix Factorization With Deep Neural Networks for Robot Hand Multiple Grasping Motion Control." In: *IEEE Robotics and Automation Letters* 8.12 (2023), pp. 8533–8540. DOI: 10.1109/LRA.2023.3329764

[4] **Caporali, A.**, Galassi, K., Palli, G., "Deformable Linear Objects 3D Shape Estimation and Tracking From Multiple 2D Views." In: *IEEE Robotics and Automation Letters* 8.6 (2023), pp. 3852–3859. DOI: 10.1109/LRA.2023.3273518

[5] **Caporali, A.**, Pantano, M., Janisch, L., Regulin, D., Palli, G., Lee, D., "A Weakly Supervised Semi-Automatic Image Labeling Approach for Deformable Linear Objects." In: *IEEE Robotics and Automation Letters* 8.2 (2023), pp. 1013–1020. DOI: 10.1109/LRA.2023.3234799

[6] **Caporali, A.**, Galassi, K., Žagar, B. L., Zanella, R., Palli, G., Knoll, A. C., "RT-DLO: Real-Time Deformable Linear Objects Instance Segmentation." In: *IEEE Transactions on Industrial Informatics* 19.11 (2023), pp. 11333–11342. DOI: 10.1109/TII.2023.3245641

2022 [7] **Caporali, A.**, Galassi, K., Zanella, R., Palli, G., "FASTDLO: Fast Deformable Linear Objects Instance Segmentation." In: *IEEE Robotics and Automation Letters* 7.4 (2022), pp. 9075–9082. DOI: 10.1109/LRA.2022.3189791

[8] **Caporali, A.**, Zanella, R., Greogrio, D. D., Palli, G., "Ariadne+: Deep Learning–Based Augmented Framework for the Instance Segmentation of Wires." In: *IEEE Transactions on Industrial Informatics* 18.12 (2022), pp. 8607–8617. DOI: 10.1109/TII.2022.3154477

Conference Proceedings

2024 [9] **Caporali, A.**, Galassi, K., Pantano, M., Palli, G., "Deformable Objects Perception is Just a Few Clicks Away–Dense Annotations from Sparse Inputs." In: *2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE. 2024, pp. 5880–5887

[10] **Caporali, A.**, Galassi, K., Berselli, G., Palli, G., "Monocular Estimation of Connector Orientation: Combining Deformable Linear Object Priors and Smooth Angle Classification." In: *2024 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)*. 2024, pp. 799–804. DOI: 10.1109/AIM55361.2024.10637081

[11] Galassi, K., **Caporali, A.**, Laudante, G., Palli, G., "Scalable Shared Encoding Architecture for Learning-Based Error Detection in Robotic Wiring Harness Assembly." In: *2024 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)*. 2024, pp. 518–523. DOI: 10.1109/AIM55361.2024.10637054

2023 [12] Žagar, B. L., **Caporali, A.**, Szymko, A., "Copy and Paste Augmentation for Deformable Wiring Harness Bags Segmentation." In: *2023 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*. 2023, pp. 721–726. DOI: 10.1109/AIM46323.2023.10196168

[13] Chiaravalli, D., **Caporali, A.**, Friz, A., Meattini, R., Palli, G., "A Vision-based Shared Autonomy Framework for Deformable Linear Objects Manipulation." In: *2023 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*. 2023, pp. 733–738. DOI: 10.1109/AIM46323.2023.10196145

2022 [14] Galassi, K., **Caporali, A.**, Palli, G., "Cable Detection and Manipulation for DLO-in-Hole Assembly Tasks." In: *2022 IEEE 5th International Conference on Industrial Cyber-Physical Systems (ICPS)*. 2022, pp. 01–06. DOI: 10.1109/ICPS51978.2022.9817006

2021 [15] **Caporali, A.**, Galassi, K., Palli, G., "3D DLO Shape Detection and Grasp Planning from Multiple 2D Views." In: *2021 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*. 2021, pp. 424–429. DOI: 10.1109/AIM46487.2021.9517655

[16] **Caporali, A.**, Galassi, K., Laudante, G., Palli, G., Pirozzi, S., "Combining Vision and Tactile Data for Cable Grasping." In: *2021 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*. 2021, pp. 436–441. DOI: 10.1109/AIM46487.2021.9517447

[17] **Caporali, A.**, Bedada, W. B., Palli, G., "A Cyber-Physical System for Clothes Detection, Manipulation and Washing Machine Loading." In: *2021 4th IEEE International Conference on Industrial Cyber-Physical Systems (ICPS)*. 2021, pp. 519–524. DOI: 10.1109/ICPS49255.2021.9468189

[18] Zanella, R., **Caporali, A.**, Tadaka, K., De Gregorio, D., Palli, G., "Auto-generated Wires Dataset for Semantic Segmentation with Domain-Independence." In: *2021 International Conference on Computer, Control and Robotics (ICCCR)*. 2021, pp. 292–298. DOI: 10.1109/ICCCR49711.2021.9349395

2020 [19] **Caporali, A.**, Palli, G., "Pointcloud-based Identification of Optimal Grasping Poses for Cloth-like Deformable Objects." In: *2020 25th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)*. vol. 1. 2020, pp. 581–586. DOI: 10.1109/ETFA46521.2020.9211879