Esteban RESTREPO

Ph.D. in automatic control

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(Last update: October 4, 2024)

Research topics: Control of multi-agents systems with application to multi-robot systems
Keywords: Automatic control, multi-agent systems, nonlinear systems, Lyapunov analysis, robotics, UAVs
Personal website: erestrep.github.io

Research experience

Current position

Nov. 2024–today **Chargé de recherche (CRCN)**,
Centre National de la Recherche Scientifique (CNRS), IRISA (UMR 6074), Rainbow team, France
- Keywords: multi-robot systems, human-robot collaboration, robot control, swarm robotics

Previous positions

Feb. 2023–Oct. 2024 **Post-doctoral researcher**,
IRISA - CNRS, INRIA Rennes – Bretagne Atlantique, France
- Postdoc in "Shared Control for Multi-Robot Systems" with Dr. Paolo Robuffo Giordano
- Keywords: Open multi-robot systems, control of collaborative UAVs, energy-aware robot control, passivity-based control

Jan. 2022–Jan. 2023 **Post-doctoral researcher**,
Division of Decision and Control Systems, KTH Royal Institute of Technology, Sweden
- Postdoc in "Hybrid Control of Multi-robot Systems" with Pr. Dimos Dimarogonas
- Keywords: Constrained control of multi-agent systems, complex network identification, control and identification of biological networks

2018–2021 **Ph.D. candidate in automatic control**,
DTIS ONERA, L2S, UMR 8506 CNRS, Université Paris-Saclay, France
- Title of the thesis: "Coordination Control of Autonomous Robotic Multi-agent Systems under Constraints." HAL Id : tel-03537341
- Keywords: Multi-agent systems, autonomous vehicles, Lyapunov methods, control with constraints
- Best thesis award from GdR MACS and Club EEA
- Time for the preparation of the thesis: 3 years and 2 months (01 octobre 2018 - 30 novembre 2021)
- Supervisors: Antonio Loría (DR CNRS), Julien Marzat (HDR Research engineer), Ioannis Sarras (Research engineer)
- Jury: Dimos Dimarogonas (PR, KTH), Paolo Robuffo Giordano (DR CNRS), Magnus Egerstedt (PR, UCI), Sandra Hirche (PR, TUM)
- Links to the defense reports:

Education

2018–2021 **Ph.D. on Information and Communication Sciences and Technologies**,
Université Paris-Saclay, Saclay, France
- Title of the thesis: "Coordination Control of Autonomous Robotic Multi-agent Systems under Constraints." HAL Id : tel-03537341

2017–2018 **M.Sc. on Advanced Systems and Robotics**,
Arts et Métiers ParisTech (ENSAM), Sorbonne Université, France
- Autonomous robots: modeling, control and perception of robotic systems
- Research internship at ONERA: "Robust guidance of a miniature drone in an environment with dynamic obstacles."

2015–2017 **Engineering degree**,
Arts et Métiers ParisTech (ENSAM), France
- Major: Mechatronics
- Internship at CorWave S.A.: Cardiac pump test-bench automation

2012–2015 **Engineering degree**,
Universidad EIA, Colombia
- Major: Mechatronics
- Double-degree program at Arts et Métiers ParisTech

Student supervision

Ph.D. students

2022 (ongoing) **Ph.D. on automatic control: "Simultaneous Network Identification and Control for Heterogeneous Multi-Agent Systems"**,
(25%) co-supervised with Pr. D. Dimarogonas & Dr. P. Tajvar, KTH Royal Institute of Technology
- Keywords: Complex networks, topology identification, synchronization, multi-agent systems
- Related publications: [C3], [J3]

Visiting Ph.D. students

2023 (6 months - ongoing) **Ph.D. visiting student: "Active-sensing estimation with multi-agent systems"**,
(40%) co-supervised with N. de Carli & Dr. P. Robuffo Giordano, IRISA-CNRS, Inria Bretagne Atlantique
- Keywords: Active sensing, distributed estimation, multi-consensus

Master's students

2024 (6 months) **Master's research internship: "Perception-Aware Cable Suspended Multi-Drone Transportation"**,
(40%) co-supervised with N. de Carli, Dr. P. Robuffo Giordano and Dr. M. Tognon, IRISA, Inria de l'Université de Rennes
- Keywords: multi-robot systems, collaborative transportation, UAVs

2024 (6 months) **Master's research internship: "MPC-based control of a cable suspended load using multiple UAV's for dynamic motion"**,
(25%) co-supervised with N. de Carli and Dr. M. Tognon, IRISA, Inria de l'Université de Rennes
- Keywords: MPC, multi-robot systems, collaborative transportation, UAVs

2021 (6 months) **Master's research internship: "Formation control of autonomous vehicles"**,
(60%) co-supervised with Dr. A. Loría , L2S CentraleSupélec
- Keywords: Nonholonomic multi-agent systems, formation control, output feedback
- Related publications: [C4]

Invited researcher

2021 (2 months) **NTNU : Norwegian University of Science and Technology**, *Trondheim, Norway*
- Research work on tracking-in-formation control of multiple marine vehicles
- In collaboration with Josef Matouš and Pr. Kristin Y. Pettersen
- Related publications: [C6], [J2]

2020 (1 month) **University of Guadalajara**, *Guadalajara, Mexico*
- Research work on consensus of multiple nonholonomic vehicles
- In collaboration with Dr. Emmanuel Nuño
- Related publications: [J5, J8, J7], [**romero2024output**]

Talks

2023 **RIS Team, LAAS - CNRS**, *Toulouse, France*,
Title: "Passivity Preserving Energy-Aware Design for Multi-Dimensional Switched Systems Application to Open Multi-Robot Systems"

2023 **Rainbow Team INRIA Bretagne - Atlantique**, *Rennes, France*,
Title: "Control of multi-agent systems under constraints: the edge-agreement framework",
(Synthesis of previous research)

2022 **Journées du Club EEA**, *online*,
Title: "Coordination control of autonomous robotic multi-agent systems under constraints"

2022 **Journées de la SAGIP**, *Bidart, France*,
Title: "Coordination control of autonomous robotic multi-agent systems under constraints"

2021 **Journée du GT SYNOBS - GdR MACS**, *Paris, France*,
Title: "Robust Rendezvous Control of UAVs with Collision Avoidance and Connectivity Maintenance"

2021 **Journée du GT UAV - GdR Robotique**, *Paris, France*,
Title: "Robust Rendezvous Control of UAVs with Collision Avoidance and Connectivity Maintenance"

2019 **Journée du GT SYNOBS - GdR MACS**, *Paris, France*,
Title: "A Lyapunov-stability theory perspective on consensus: applications to control of autonomous multi-agent systems"

Awards and prizes

2022 **Best thesis award**, *GdR MACS and Club EEA*

2021 **Best thesis award**, *ONERA*

2020 **Best presentation award**, *Journée des doctorants L2S Centralesupélec*

2018 **Silver medal for academic excellence** (MSc degree), *Arts et Métiers ParisTech*

Other activities

2023 **Organization of a Workshop**, *IROS 2024, Abu Dhabi, UAE*
- Title: "Real-World Challenges in Multi-Robot Cooperation"
- Main organizer in collaboration with Dr. P. Robuffo Giordano (CNRS), Pr. H. J. Kim (Seoul National University), A. Marino (Université de Rennes)
- Website:

2022 **Writing of an ERC Consolidator Project "SYMBIOTICS: Symbiosis of biological landscapes and humanity through robotics"**, *Submitted to the call HORIZON-CL4-2022-DIGITAL-EMERGING-01 (Not retained)*
- Participated in the meetings for defining the project: context, objectives, work packages
- Writing of the methodology, objectives, tasks, deliverables, milestones, risks, associated to the Work Packages assigned to *KTH Royal Institute of Technology*

2022 **Lecturer for the FEL3330 Ph.D. Course on Networked and Multi-Agent Control Systems**, *KTH Royal Institute of Technology*,
Graduate course on consensus algorithms for multi-agent systems
- Designed and delivered a guest lecture on Agreement Protocols based on the edge Laplacian for ≈ 30 graduate students

Reviewer for international scientific journals and conferences

- **Journals :** Automatica, IEEE Transaction on Automatic Control, IEEE Transactions on Robotics, IEEE Control Systems Letters, IEEE Transactions on Control of Network Systems, IEEE Robotics and Automation Letters, Systems & Control Letters, Journal of Guidance Control and Dynamics, IEEE Transactions on Cybernetics
- **Conferences :** IEEE Conference on Decision and Control, European Control Conference, IEEE International Conference on Robotics and Automation, American Control Conference

Languages and skills

- English (fluent), French (bilingual), Spanish (mother tongue), Italian (basic knowledge).
- [Programming and Robotics] : Matlab – Simulink – C++ – Python – LabVIEW – ROS – Gazebo

Scientific output

In the control and robotic communities the order of the authors is based on the level of contribution. In general, the first author is the main contributor to the paper, while the last authors are the one that have supervised and/or instantiated the work.
All productions mentioned below are available on my personal website and shared on HAL or GitHub. They are ordered chronologically and listed from the most recent to the oldest by category as follows:
- [J] for the published articles in international peer-reviewed scientific journals
- [C] for the articles presented at international peer-reviewed scientific conferences
- [Pr] for the pre-published articles or in preparation to be submitted to international peer-reviewed scientific journals and conferences

- [B] for book chapters published in peer-reviewed scientific volumes.
- [G] for algorithms related to scientific articles and shared on GitHub

Category	Amount	Label
International journal articles	12	[J]
International conference articles	11	[C]
Submitted journals & conferences	1	[Pr]
Book chapters	1	[B]
Algorithms shared on GitHub	1	[G]

Articles in international scientific journals

[J1] De Carli, N., **Restrepo, E.**, Robuffo Giordano, P., "Adaptive Observer From Body-Frame Relative Position Measurements for Cooperative Localization". In: *IEEE Control Systems Letters* 8 (2024), pp. 1337–1342. DOI: 10.1109/LCSYS.2024.3410893, HAL: hal-04610053

[J2] **Restrepo, E.**, Matouš, J., Pettersen, K. Y., "Tracking Control of Cooperative Marine Vehicles Under Hard and Soft Constraints". In: *IEEE Transactions on Control of Network Systems* (2024), pp. 1–12. DOI: 10.1109/TCNS.2024.3378392, HAL: hal-04429664

[J3] **Restrepo, E.**, Wang, N., Dimarogonas, D. V., "Simultaneous Topology Identification and Synchronization of Directed Dynamical Networks". In: *IEEE Transactions on Control of Network Systems* 11.3 (2024), pp. 1491–1501. DOI: 10.1109/TCNS.2023.3338253, HAL: hal-04395134v1

[J4] **Restrepo, E.**, Robuffo Giordano, P., "Distributed Biconnecitvity Achievement and Preservation in Multi-Agent Systems". In: *IEEE Control Systems Letters* 7 (2023), pp. 3289–3294. DOI: 10.1109/LCSYS.2023.3324837, HAL: hal-04250466v1

[J5] Romero, J. G., Nuño, E., **Restrepo, E.**, Sarras, I., "Global Consensus-based Formation Control of Nonholonomic Mobile Robots with Time-Varying Delays and without Velocity Measurements". In: *IEEE Transactions on Automatic Control* (2023), pp. 1–8. DOI: 10.1109/TAC.2023.3264744

[J6] **Restrepo, E.**, Dimarogonas, D. V., "On Asymptotic Stability of Leader–Follower Multiagent Systems Under Transient Constraints". In: *IEEE Control Systems Letters* 6 (2022), pp. 3164–3169. DOI: 10.1109/LCSYS.2022.3182846

[J7] Romero, J. G., Nuño, E., **Restrepo, E.**, Cisneros, R., Morales, M., "A Smooth Time-Varying PID Controller for Nonholonomic Mobile Robots Subject to Matched Disturbances". In: *Journal of Intelligent & Robotic Systems* 105.13 (2022). DOI: 10.1007/s10846-022-01622-3

[J8] Nuño, E., Loría, A., Panteley, E., **Restrepo, E.,** "Rendezvous of Nonholonomic Robots via Output-Feedback Control under Time-varying Delays". In: *IEEE Transactions on Control Systems Technology* (2022), pp. 1–10. DOI: 10.1109/TCST.2022.3144031, HAL: hal-03752270v2

[J9] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Robust Consensus of High-Order Systems under Output Constraints: Application to Rendezvous of Underactuated UAVs". In: *IEEE Transactions on Automatic Control* (2021). DOI: 10.1109/TAC.2022.3144107, HAL: hal-03275331v2

[J10] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Edge-based strict Lyapunov functions for consensus with connectivity preservation over directed graphs". In: *Automatica* 132 (2021), p. 109812. DOI: 10.1016/j.automatica.2021.109812, HAL: hal-03306580v1

[J11] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Stability and robustness of edge-agreement-based consensus protocols for undirected proximity graphs". In: *International Journal of Control* (2020), pp. 1–9. DOI: 10.1080/00207179.2020.1800101, HAL: hal-02932046v1

[J12] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Leader-follower Consensus of Unicycles with Communication Range Constraints via Smooth Time-invariant Feedback". In: *IEEE Control Systems Letters* 5.2 (2020), pp. 737–742. DOI: 10.1109/LCSYS.2020.3005181, HAL: hal-02901383v1

Articles presented at international scientific conferences

[C1] **Restrepo, E.**, Robuffo Giordano, P., "A Distributed Strategy for Generalized Biconnectivity Maintenance in Open Multi-robot Systems". In: *63rd IEEE Conference on Decision and Control (CDC)* (2024). To appear.

[C2] Wang, N., **Restrepo, E.**, Dimarogonas, D. V., "Simultaneous Topology Estimation and Synchronization of Dynamical Networks with Time-varying Topology". In: *63rd IEEE Conference on Decision and Control (CDC)* (2024). To appear. arXiv

[C3] **Restrepo, E.**, Wang, N., Dimarogonas, D. V., "Simultaneous Synchronization and Topology Identification of Complex Dynamical Networks". In: *62nd IEEE Conference on Decision and Control (CDC)* (2023), pp. 393–398. DOI: 10.1109/CDC49753.2023.10383578

[C4] Lazri, A., **Restrepo, E.**, Loría, A., "Robust leader-follower formation control of autonomous vehicles with unknown leader velocities". In: *2023 European Control Conference (ECC)* (2023), pp. 1–6. DOI: 10.23919/ECC57647.2023.10178165, HAL: hal-03869953v1

[C5] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Consensus of Open Multi-agent Systems over Dynamic Undirected Graphs with Preserved Connectivity and Collision Avoidance". In: *61st IEEE Conference on Decision and Control (CDC)* (2022), pp. 4609–4614. DOI: 10.1109/CDC51059.2022.9993102, HAL: hal-03788968v2

[C6] **Restrepo, E.**, Matouš, J., Pettersen, K. Y., "Tracking-in-Formation of Multiple Autonomous Marine Vehicles under Proximity and Collision-Avoidance Constraints". In: *2022 European Control Conference (ECC)* (2022), pp. 930–937. DOI: 10.23919/ECC55457.2022.9838207, HAL: hal-03513288v1

[C7] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Robust Rendezvous Control of UAVs with Collision Avoidance and Connectivity Maintenance". In: *2022 American Control Conference (ACC)* (2022), pp. 4733–4738. DOI: 10.23919/ACC53348.2022.9867434, HAL: hal-03752235v1

[C8] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Distributed full-consensus control of multi-robot systems with range and field-of-view constraints". In: *2021 IEEE International Conference on Robotics and Automation (ICRA)*. 2021, pp. 1890–1895. DOI: 10.1109/ICRA48506.2021.9561551, HAL: hal-03334305v1

[C9] **Restrepo, E.**, Sarras, I., Loría, A., Marzat, J., "Leader-follower consensus of unicycle-type vehicles via smooth time-invariant feedback". In: *In Proceedings of the European Control Conference* (2020), pp. 917–922. DOI: 10.23919/ECC51009.2020.9143718, HAL: hal-02874007v1

[C10] **Restrepo, E.**, Loría, A., Sarras, I., Marzat, J., "Robust Consensus and Connectivity-maintenance under Edge-agreement-based Protocols for Directed Spanning Tree Graphs". In: *IFAC-PapersOnLine* 53.2 (2020), pp. 2988–2993. 21st IFAC World Congress. DOI: 10.1016/j.ifacol.2020.12.978, HAL: hal-02917400v1

[C11] **Restrepo, E.**, Sarras, I., Loría, A., Marzat, J., "3D UAV Navigation with Moving-Obstacle Avoidance Using Barrier Lyapunov Functions". In: *IFAC-PapersOnLine* 52.12 (2019), pp. 49–54. Presented at the 21st IFAC Symposium on Automatic Control in Aerospace. HAL: hal-02355276v1

Pre-published articles or in preparation

[Pr1] **Restrepo, E.**, Secchi, C., Robuffo Giordano, P., "Passivity Preserving Energy-Aware Design for Multi-Dimensional Switched Systems: Application to Open Multi-Robot Systems". In: *Automatica* (2023). Submitted as a full paper. HAL: hal-04330519

Book chapters in peer-reviewed scientific volumes

[B1] Loría, A., Nuño, E., Panteley, E., **Restrepo, E.,** "Physics-based output-feedback consensus-formation control of networked autonomous vehicles". In: *Hybrid and Networked Dynamical Systems*. Ed. by R. Postoyan, P. Frasca, E. Panteley, and L. Zaccarian. Lecture Notes in Control and Information Sciences. London: Springer Verlag, 2024. HAL: hal-04298646

Algorithms related to scientific articles shared on GitHub

[G1] https://github.com/erestrep/Multi-robot_Control_Gazebo, **Restrepo, E.,** *Code for Gazebo simulations and experimental implementation on robots.* . Related publications: [J4,J6,J7,J11,C6,C7,B1, Pr1].

Thesis

[Thesis1] **Restrepo, E.** "Coordination control of autonomous robotic multi-agent systems under constraints". PhD thesis. Université Paris-Saclay, 2021. HAL Id : tel-03537341