Ioannis Mandralis

CURRICULUM VITAE

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Short Bio

- Currently: PhD candidate at Caltech working on learning & control for aerial robots with non-trivial morphologies in challenging environments.
- Experience on ground-up development of robotic systems in academia & industry with proven field demonstrations.
- Extensive research experience with model-predictive control, deep reinforcement learning, full-stack software development, and hardware deployment.
- Author of 10 full-paper scientific publications (3 Journal, 5 Conference, 2 preprints & under review).

Education

2021-Present **Caltech, USA**
PhD Aerospace Engineering

Dissertation: Learning & Control for Mid-Air Robotic Transformation.

Advisors: Dr. Morteza Gharib & Dr. Richard Murray.

2018-2020 **ETH Zurich, Switzerland**
MSc Mechanical Engineering

Specialization: Robotics, AI, & Control

Thesis: Reinforcement Learning for Control of Swimmers in Flow Simulations.

Advisor: Dr. Petros Koumoutsakos.

2015-2018 **EPFL, Switzerland**
BSc Mechanical Engineering

One year exchange at McGill, Canada (2017-18).

Honors and awards

Selected list of honors and awards.

Sep 2022	**Onassis Foundation Scholarship** Awarded by the Onassis Foundation to exceptional students for PhD studies for a period of 3+ years.
June 2022	**Rolf D. Buhler Memorial Prize in Aeronautics** Awarded by the Caltech Aerospace department to student with highest GPA in first year of PhD studies.
Dec 2020	**Degree Distinction Prize, ETH Zurich** Highest degree distinction at ETH Zurich: awarded to students achieving a GPA of >5.75/6.

Research experience

I work on a broad range of topics all related to autonomy of robotic systems. My approach relies on using new tools from learning & control with an emphasis on applying them to hardware and bringing ideas to reality.

2021-Present

PhD Researcher at Caltech, Pasadena CA.
Advisors: Dr. Morteza Gharib & Dr. Richard Murray.
Laboratory: Center for Autonomous Systems & Technology (CAST).

Research projects

- Participated in development of the M4 robot: a multi-modal robot capable of flying, driving, crawling, segwaying, and more.
- Led development of the ATMO robot: an aerially transforming morphobot capable of mid-air transformation.
- Designed software, hardware, as well as control, & autonomy packages. Built ATMO's system architecture from ground-up using C++, Python, and ROS/ROS2 and tools like CasAdi & Acados for MPC and Isaac Lab/Gym for Deep Reinforcement Learning.
- Experimentally validated the first adaptive MPC algorithm that enables mid-air transformation for dynamic ground-aerial transition.
- Developed an end-to-end Deep Reinforcement learning controller and compared to the model-predictive control method.
- Developed a self-supervised computer-vision method which takes RGBD camera information and produces a cost-of-transport map used for multi-modal path planning.

Other activities

- Part of a small group of researchers leading the development of novel shape sensing methods for thin wires. Developed machine learning tools for shape reconstruction and wrote patents.
- Led software, hardware, & autonomy design for industry partners TII in Abu Dhabi. Performed live field demonstration with media coverage available at the bottom of the page here.
- Designed software & hardware for a multi-modal flying driving robot for government partners. Demonstrated robot live in Caltech's CAST Annual Program review with video available here.

Master Students Advised

- Quentin Delfosse (EPFL)
  Thesis: "Reinforcement-learning based navigation for a multi-modal robot", September 2024.
- Gabriel Margaria (EPFL)
  Thesis: "Adaptive control of a Multi-Modal Robot using Deep Reinforcement Learning", August 2024.
- Vincent Gherold (EPFL)
  Thesis: "Self-supervised cost of transport estimation for multimodal path planning", August 2024.
- Severin Schumacher (TUM)
  Thesis: "Experimental Analysis of the Transition and Landing Phase of a Flyable Rover", September 2023.

Undergraduate Students Advised

- Diego Garcia (Caltech)
  Senior Project: "Flying Carpet: A flexible flying surface for multi-modal flight", June 2024.
- Sofia Wan (Caltech)
  SURF project: "Hardware development for a flexible flying surface," June 2023.
- Steven Lei (Caltech)
  SURF project: "Hardware development for a flexible flying surface," June 2023.

2018-2021 **Research Affiliate** in the CSELab at ETH Zurich/Harvard.
Advisor: Dr. Petros Koumoutsakos

- Coupled a Deep Reinforcement Learning solver with a 2D Navier Stokes Fluid Simulator.
- Employed learning algorithms to obtain optimal fish swimming patterns under energy constraints.
- Employed learning algorithms for micro-swimmers navigating in unknown flow fields.
- Designed a Generative Adversarial Network for learning distributions of stochastic dynamical systems.
- Tested the system for predicting Alanine Dipeptide protein kinetic compared to molecular dynamics simulations.

2017-2018 **Undergraduate Researcher** EMSI Lab at EPFL.
Advisor: Dr. John Kolinski

- Built an experimental optics setup for two-dimensional photoelasticity
- Extended two-dimensional setup for tomography of 3D materials.

Professional Experience

Outside of academia I have had the chance to work as a software engineer and a mechanical engineer intern in industry.

Sep 2019-Apr 2020 **Robotics Software Engineer** at ANYbotics AG, Zurich CH.

Projects & involvement

- Developed a novel parameter estimation technique to improve walking performance on the ANYmal robot.
- Implemented the identification software in C++ and Python.
- Tested the software in the field.
- Participated in general software development tasks in C++, Python, and ROS as part of the control & locomotion team.

Summer 2017

Mechanical Engineer Intern at Nestlé R&D Systems & Technology Center, Lausanne Switzerland.

- Designed and 3D printed mechanical parts for coffee dispensing systems using SolidWorks.

Teaching experience

I have actively sought out teaching & mentorship roles at the Universities I have studied. The most notable experiences are listed below:

2022-Present

Caltech, Pasadena, CA.

Head TA, Optimal Control & Estimation, Winter 2023.
- Professor: Dr. Richard Murray.
- Developed guest lectures, homework, and exams for 20 students.
- Class Website.

Head TA, Linear Systems Theory, Fall 2023.
- Professor: Dr. Amir Rahmani.
- Developed guest lectures, graded homework, and exams for 15 students.

2018-2020

ETH Zurich, Zurich, CH.

Teaching Assistant, Multivariable Control, Spring 2020.
- Graded homeworks and exams for a class of 150 students.

2015-2018

EPFL, Lausanne, CH.

Teaching Assistant, Thermodynamics, Spring 2017
- Conducted weekly 15 min blackboard lectures, followed by discussion for a class of 20 students.

Teaching Assistant, Analytical Mechanics, Fall 2016.
- Solved exercises on blackboard weekly and answered questions for a class of 30 students.

Publications

For a full list of publications please see my google scholar page.

Journal publications

I. Mandralis, R. Nemovi, A. Ramezani, RM. Murray, M. Gharib, "ATMO: An Aerially Transforming Morphobot for Dynamic Ground-Aerial Transition", *To Appear*: Nature Communications Engineering, (link).

P. Gunnarson, I. Mandralis, G. Novati, P. Koumoutsakos & JO. Dabiri, "Learning efficient navigation in vortical flow fields." Nature Communications 12,7143, (2021), (link).

I. Mandralis, P. Weber, G. Novati, P. Koumoutsakos, "Learning swimming escape patterns under energy constraints." Phys. Rev. Fluids 6, 093101, (2021). (link)

Journal papers in review

AA. Stefan-Zavala, I. Scherl, I. Mandralis, SL. Brunton, M. Gharib, "Data-Driven Modeling for On-Demand Flow Prescription in Fan-Array Wind Tunnels", Submitted to: Flow. (link)

V. Gherold, I. Mandralis, E. Sihite, A. Salagame, A. Ramezani, M. Gharib, "Self-supervised cost of transport estimation for multimodal path planning", Submitted to: RAL. (link)

Conference papers

B. Gupta et. al., "Bounding Flight Control of Dynamic Morphing Wings," 2024 IEEE International Conference on Advanced Intelligent Mechatronics (AIM), Boston, MA, USA, 2024, pp. 100-105, (link).

A. Salagame et al., "How Strong a Kick Should be to Topple Northeastern's Tumbling Robot," 2024 IEEE International Conference on Advanced Intelligent Mechatronics (AIM), Boston, MA, USA, 2024, pp. 76-81, (link).

E. Sihite *et al*., "Demonstrating Autonomous 3D Path Planning on a Novel Scalable UGV-UAV Morphing Robot," *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Detroit, MI, USA, 2023, pp. 3064-3069, (link).

A. Dhole *et al*., "Hovering Control of Flapping Wings in Tandem with Multi-Rotors," *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Detroit, MI, USA, 2023, pp. 6639-6644, (link).

I. Mandralis, E. Sihite, A. Ramezani and M. Gharib, "Minimum Time Trajectory Generation for Bounding Flight: Combining Posture Control and Thrust Vectoring," 2023 European Control Conference (ECC), Bucharest, Romania, 2023, (link).

Patents

A. Rosakis, I. Mandralis, M. Gharib, "Thin Wire Shape Sensing" patent pending (Jan 2025).

I. Mandralis, S. Schumacher, R. Nemovi, M. Gharib, "Thrust Recapture for Morphing Aerial Vehicles with Out-of-Plane Thrusters," patent disclosure obtained submission to US Patent Office (Sep 2024).

Presentations

March 2023	"Thrust recapture for morphing aerial vehicles with out of plane thrusters," March Meeting APS, Washington DC, (link).
March 2023	"Fan Array Wind Tunnels: Spatially Resolved Characterization and Data-Driven Modeling", March Meeting APS, Washington DC, (link).
March 2021	"Investigation of surface pressure fluctuations in airfoils subject to transverse gust: towards gust mitigation," March Meeting APS, Phoenix AZ, (link).

	March 2021	"Robotic Implementation of Online Deep Reinforcement Learning for Autonomous Underwater Navigation," March Meeting APS, Phoenix AZ, (link).

Professional service

2021-Present	**Peer-Reviewed Articles for** ICRA, IROS
Dec 2021	**ETH Ambassador** for the Global Young Scientist Summit, Singapore, 2021 10 students selected from entire body of PhD students, Post-Docs and Master students at ETHZ to attend this summit.

Languages

English	Native
Greek	Native
French	Native
Spanish	Fluent
German	Beginner

Skills

Programming	C/C++, Python/Cython, ROS, PyTorch, Tensorflow, LaTeX, sci-kit learn, Docker, Git, Pandas, Matlab.
Computer Science	Machine Learning, Deep Reinforcement Learning, Isaac Gym, Transformers, Convolutional Nets, Parallel Programming, Embedded Systems.
Other	Solidworks, 3D printing, Electronics, Simulink.

Interests

Sim2real transfer, machine learning, algorithms, parallel programming, LLM's, robotics foundation models, zero-shot transfer learning, nonlinear control, adaptive control, nonlinear dynamics, deep reinforcement learning, residual learning.

References

Dr. Morteza Gharib	Hans W. Liepmann Professor of Aeronautics and Medical Engineering; Booth-Kresa Leadership Chair, Center for Autonomous Systems and Technologies; Director, Graduate Aerospace Laboratories; Director, Center for Autonomous Systems and Technologies. Phone: 626-395-2118, Email: mgharib@caltech.edu, Website.
Dr. Richard Murray	Thomas E. and Doris Everhart Professor of Control and Dynamical Systems and Bioengineering. Phone: 626-395-2464, Email: rmurray@caltech.edu , Website.
Dr. Alireza Ramezani	Associate Professor of Electrical and Computer Engineering. Phone: 617-373-4027, Email: a.ramezani@northeastern.edu, Website.
Dr. John Dabiri	Centennial Professor of Aeronautics and Mechanical Engineering.

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