UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

Dottorato di Ricerca in Ingegneria dell'Informazione

Doctoral Course

"Modeling and control of multi-rotor aerial robots"

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Short Abstract:

Multi-rotor aerial vehicles (MAVs)—commonly known as drones—are becoming increasingly ubiquitous due to their favorable characteristics, such as versatility and low cost, and their broad range of applications, ranging from industrial inspection to sustainable weed and crop management. Beyond traditional passive uses, where these robots monitor the environment (e.g., video recording, imaging, mapping), new directions have emerged—originating in research labs and now reaching the market—including dexterous designs capable of controlling the full 6D pose and instantaneously exerting forces in all directions. The field of aerial manipulation, which investigates physical interaction between aerial robots and their environment, has seen significant advances, enabling MAVs to perform contact-based tasks and transport both rigid and deformable objects, individually or cooperatively. In this course, you will explore the fundamentals and recent developments in MAV modeling and control, starting from the standard underactuated quadrotor to innovative fully-actuated designs. You will also examine how fully-actuated MAVs interact physically with their environment and how multiple quadrotors can collaboratively manipulate rigid and deformable objects.

Course Contents in brief:

- Introduction: multi-rotor aerial robots, the Neutraweed project and other ongoing research at the Robotics and Mechatronics group of the University of Twente (45 min)
- Propeller modeling (1h 15min)
- Multi-rotor aerial robot dynamics (2h)
- Quadrotor (2h)
- Fully-actuated hexarotor with fixedly-tilted propellers (2h)
- Aerial Manipulation: physical interaction control for a fully-actuated aerial manipulator (2h)
- Omnidirectional tilting-propeller robot (2h)
- Omnidirectional robot with synchronously tilting propellers (2h)
- Aerial Manipulation: cable-suspended objects – modeling and differential flatness (2h)
- Aerial Manipulation: deformable objects - modeling and differential flatness (2h)
- Final Exam (2h)

Total # of hours of lecture: 20

CV of the Teacher

Chiara Gabellieri is an Assistant Professor in the Robotics and Mechatronics group (EEMCS faculty) at the University of Twente, the Netherlands, where she co-supervises 3 PhD candidates. She received the Marie Skłodowska-Curie (MSCA) Postdoctoral Fellowship with the Flyflic project in 2022 and is a local PI of the MSCA Staff Exchange project Neutraweed, as well as a co-applicant in the NWO-OTP AVIATOR project. She has been a Work Package leader in the European coordination and support project AeroSTREAM, ended in 2025.

From the University of Pisa, she received her Ph.D. in Information Engineering in 2021, her MSc. in Robotics and Automation Engineering with honors in 2017, and her BSc. in Bioengineering in 2014.

She was at LAAS-CNRS in Toulouse, France, from Nov. 2017 to May 2018, and a visiting Ph.D. student at the German Aerospace Center (DLR) in Oberpfaffenhofen from Nov. 2019 to May 2020. She is an Associate Editor (AE) for the IEEE RA-L (2023-) and member of the Editorial board of the Unmanned Aviation Magazine eUAM (2025-) and was AE for ICRA 2022-25 and IROS 2023-25.

Final Exam: Written exam, 5 open questions.

Room and Schedule

Room: *Meeting Room, Dept. of Information Engineering, Largo Lazzarino 1, Pisa, Sixth Floor*

Schedule:

12/01 8:30-12:30

13/01 8:30-12:30, 14:00-16:00

14/01 8:30-12:30

15/01 8:30-12:30

16/01 8:30-10:30 (Exam)

The course is in the framework of the educational activities of IEEE Student Branch at the University of Pisa	IEEE STUDENT BRANCH – UNIVERSITY OF PISA