Full-body Planning and Control of an Aerial Robotic Manipulator

Introduction

Aerial robots can be equipped with robotic arms with multiple degrees of freedom to perform highly dexterous operations at altitude. Instead of traditional drones, these flying machines are "flying hands" that can replace workers in dangerous and hard-to-reach locations, such as on electrical towers or offshore wind turbines. However, the design and control of these aerial robotic manipulators present a major challenge. The traditional approach separates the dynamics of the manipulator and the drone by assuming that the robotic arm is light and moves slowly. However, these assumptions are no longer valid if the aerial manipulator operates in a motionless manner.

In this project, you will work on designing full body control of air manipulators without the above assumptions. You will have to directly control the torque level of the actuators and jointly account for the multiple DoF kinodynamics of both the manipulator and the base of the drone. As a result, the aerial manipulator is expected to have unprecedented agility and maneuverability compared to state-of-the-art solutions. You will also work closely with the engineer to build and modify the air manipulators in the lab.

Research question

- How to design full-body planning and control of an aerial manipulator?
- How to achieve reliable torque level control of aerial robotic manipulators from a hardware perspective?

What we expect from you:

- Highly motivative.
- Experience in programming languages such as Python and C++.
- Knowledge in robotic dynamics and nonlinear control.
- Experience with Matlab \ Simulink is a bonus.
- Experience with real-world experiments with drones is a bonus.

What you can learn from this project:

- Hands-on experience with the modelling and control of multi-UAV (aerial robot) systems.
- Hands-on experience and knowledge in robotic mechatronics.
- Chance to publish in high-ranking robotic and ML conferences/journals.

Reference

[1] Ollero, Anibal, et al. "Past, present, and future of aerial robotic manipulators." *IEEE Transactions on Robotics* 38.1 (2021): 626-645.

[2] Zhao, Moju, et al. "Whole-body aerial manipulation by transformable multirotor with two-dimensional multilinks." *2017 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2017.

[3] Ryll, Markus, et al. "6D physical interaction with a fully actuated aerial robot." *2017 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2017.

[4] Lippiello, Vincenzo, and Fabio Ruggiero. "Exploiting redundancy in Cartesian impedance control of UAVs equipped with a robotic arm." *2012 IEEE/RSJ International Conference on Intelligent Robots and Systems*. IEEE, 2012.

Contact:

If you are interested in conducting this cool project, please contact Dr. Sihao Sun via s.sun-2@tudelft.nl

When applying, please provide a short motivation, an up-to-date CV, a transcript of your current degree program and an intended start date.

Short bio of the supervisor:

Dr. Sihao Sun is a new member of CoR funded by the NWO talent program “Veni” grant. He has intensive experience in the control, planning, estimation and machine learning of aerial robotic systems by working at ETH-Z/UZH, University of Twente, and TU Delft. He’s the winner of the Best Paper Award of Robotics and Automation Letters (RAL) and the NASA Tech Brief award. He has supervised over 20 MSc students, and three of them won CumLaude respectively in TU Delft and ETH-Z/UZH.