ETH1: Autonomous Micro Aerial Vehicles

Hosted by the ETH Zurich
Course dates: 4 - 8 July 2011

Course Description

Autonomous aerial vehicles are about to play major roles in tasks like reconnaissance for search and rescue, environment monitoring, security surveillance. Their mobility and sensing capabilities – unavailable ground robots – make them the ideal platform for exploration, mapping, and monitoring tasks, and for transport/delivery of payloads in complex 3-dimensional environments. If they are further realized in small scale, they can also be used in narrow outdoor and indoor environments, and they represent only a limited risk for the environment and people living in it. However, for such operations today's systems navigating only on GPS information are no longer sufficient. Fully autonomous operation in cities or other dense environments requires the micro aerial vehicle (MAV) to fly at low altitude or indoors – where GPS signals are often shadowed – and to explore actively unknown environments while avoiding collisions and creating maps. This involves a number of challenges on all levels: helicopter design, power supply, perception, actuation, navigation, and control.

In this summer school we will give a compact introduction into the engineering fundamentals of micro aerial vehicles, from design to perception and control. Within this scope, we will first provide the participants with knowledge on design and simulation of different configurations of micro aerial vehicles. We will specifically focus on the design of micro helicopters, namely coaxial and quadrocopters. Second, we will provide the state of the art on sensors for MAVs, both proprioceptive and exteroceptive sensors and we will focus in particular on inertial (IMU) and vision sensors as alternative to the more standard laser and GPS. Within this scope, we will include lectures and exercises on fusion of vision and IMU, visual SLAM, and visual place recognition. Emphasis will be given to the design of computationally inexpensive algorithms for low-power, lightweight processors. Finally, we provide the participants with knowledge on control strategies and navigation algorithms for MAVs, stressing the importance of learning from nature.

A number of selected case studies presented by internationally recognized experts in the field, will point to areas of stimulating research and allow you to see beyond the current state of the art.

The school is designed for graduate students of all levels. A solid background in engineering will enable you to profit most from the lectures and exercises, but the course might still serve as good an introduction to people with a different background, who want to learn more about this inspiring field. The summer school is part of the Swiss National Competence Center for Research in Robotics.

Target Audience

Primarily graduate students of all levels or students who have completed undergraduate studies with a solid background in engineering. However, students with a different background who want to learn more about this inspiring field are also welcome.

Delivery Method, Exams & Learning Outcomes

This course will be given in 4 three-hour lectures and 3 three-hour exercises, and will feature 2 sessions of case studies. An exam will be done on the last day to the student who will need ECTS credits (this course is worth 2ECTS credits).

Course schedule

Monday, 4 July:
9.30-12.30 -> Rotorcraft configurations and design
14.00-17.00 -> Exercises
Tuesday, 5 July:
9.30-12.30 -> Control and path planning
14.00-17.00 -> Exercises
Wednesday, 6 July:
9.30-12.30 -> Sensors and perception
14.00-17.00 -> Exercises
Thursday, 7 July:
9.30-12.30 -> Case study I: fusion of camera and inertial sensors
14.00-17.00 -> Visual SLAM for MAV navigation
Friday, 8 July:
9.30-12.30 -> Case study II: distributed control and aggressive maneuvers
14.00-17.00 -> Final exam

Prof Roland Siegwart, Dr Davide Scaramuzza, Dr Margarita Chli, Dr. Samir Bouabdallah and external speakers will be conducting this course.

Where you will stay

We will provide basic accommodation for all participants in a remodeled former air-raid shelter in the basement of the Computer Science building (no windows). This is right next door to the main building, and will feature dormitory style rooms with shared bathrooms. This accommodation will be free of charge for all participants. It will be open from Sunday evening to Saturday morning, to accommodate travel that requires an additional night in Zurich.

If more privacy and comfort is desired, students must organize alternative accommodation on their own responsibility and expense (double rooms start at around CHF 65 per night and person).

Costs

Tuition fee: Waived for IARU partner students
Accommodation: Basic accommodation (air-raid shelter) is free of charge
Miscellaneous: CHF200 for all course materials, as well as breakfast, coffee-breaks, and two dinners during the school.
Living Expenses: CHF200 (estimated). Lunch and dinner is available at the ETH Zurich Cafeterias and in nearby venues from ~15 CHF (including a drink)