Specialized Master of Science in Robotics, Systems and Control

ETH Zurich
D-MAVT, D-INFK, D-ITET, D-HEST

https://master-robotics.ethz.ch/
Robotics, Systems and Control
Interdisciplinary, exciting and highly demanded in industry

• Key Topics
  – **Robotics and Systems Engineering**
    – Design, modelling, optimization and control
  – **Physical Modelling and Simulation**
  – **Optimization and Control**
  – **Artificial Intelligence & Machine Learning**
  – **Perception, Graphics, Virtual Reality**
  – **Embedded and Distributed Computing**

• Challenging Applications
  – mobility, logistics, autonomous transportation, VR/AR, automated construction, smart farming, health care, search and rescue, sustainability, …

• Tutor-Based
  – You define with the help of your Tutor your individual program → it is your program
Curriculum Structure
*Individual programme defined with the help of your tutor*

<table>
<thead>
<tr>
<th>Category</th>
<th>CP</th>
<th>Description</th>
</tr>
</thead>
</table>
| Core Courses                      | 36 | • Basis of the Master’s Program  
• Providing core knowledge in the respective area of specialization  
• Choice of courses in accordance with tutor |
| Multidisciplinary Courses         | 6  | • Complement your knowledge in the field  
• Courses at ETH, Uni Zürich and HSG  
• Choice of courses in accordance with tutor |
| Science in Perspective            | 2  | • General-education courses in humanities, social and political science from the course catalogue of D-GEll ETH Zürich |
| Semester Project                  | 8  | • Use of acquired technical knowledge  
• Provides experience in solving a specific engineering problem |
| Industrial Internship             | 8  | • Min. 12-week internship in a Swiss or foreign company / research institute                       |
| Master’s Thesis                   | 30 | • Conclusion of the Master’s Program  
• Independent and scientific work |
Why a Specialized Master?

• Distinction
  – through the Master Program after a „generic“ Bachelor in one of the engineering disciplines
• Interdisciplinary
  – across engineering and beyond
• High Quality Program
  – with international leaders in the field
  – distinguished seminar in Robotics, Systems and Controls
  – topical summer schools
• Selective Admission
  – highly motivated and qualified students
• Highly Relevant Fields and Large Demand in Industry
  – in Switzerland, Europe and the world
Excellent Science is the Foundation for Innovation

Top 20 most cited robotics scientist in Europe (h-index)

- ETH, Switzerland
- University of Freiburg, Germany
- UniPisa/IIT, Italy
- Bielefeld University, Germany
- EPFL, Switzerland
- Scuola Superiore Sant’Anna, Italy
- DLR, Germany
- CNRS/ENS/INRIA, France
- IIT, Italy
- TU Munich, Germany
- Sapienza Univ. of Rome, Italy
- TU Darmstadt, Germany

ICRA 2019
- Number of publications normalized by population

Citations per paper

Master of Science in Robotics, Systems and Control - https://master-robotics.ethz.ch/
Switzerland | a melting pot for robotics technology

How Switzerland Became The Silicon Valley Of Robotics

Andrew Cave, CONTRIBUTOR

14.03.2022 6
Robotics, Systems and Control

Some Examples
A Large Diversity of Exciting Research Challenges

- learning-based control
- planning and decision making for AVs
- people detection and tracking
- embedded computer vision
- VR / AR
- deep learning for machine perception of human activity
- 3D human modelling
- optimal control
A Large Diversity of Exciting Research Challenges

- Biomimetic underwater robots
- Soft object manipulation
- Exoskeleton
- Healthcare and diagnostics
- Magnetic manipulation for intra-body navigation
- Rehabilitation robotics
- Soft inflatable robotics
Walking Robot ANYmal | designed for challenging environments

ANYmal – “soft” interaction with the environment
| the ultimate quadruped

https://www.youtube.com/watch?v=EI1zBTYpXW0
Reinforcement Learning  |  robot learning to walk

- Goal: given the actual state, learn the best action (leg movements) to achieve the optimal next state.
Flying Robots | pushing the flight endurance

wingtra

| the VTOL UAV (hybrid)
https://www.youtube.com/watch?v=QADvPDWtgFU

Atlantik Solar

| 81 hours non-stop in summer 2015
| 5.64 m, 6.2 kg
https://www.youtube.com/watch?v=8m4_NpTQn0E
https://www.youtube.com/watch?v=wyS6W1t_ryQ
Next-generation Drones | *interactive omnidirectional flying*

- **Goal:**
  - Fly in all directions at any attitude of the main body
  - Generate forces in all directions in order to interact with the environment

---

*Push-and-Slide Along a Flat Surface (Section V-C)*

- Reject disturbances from friction forces
- Accurately and repeatably draw a pattern (3 trials)

---

https://www.youtube.com/watch?v=9FJn_t-YCwM
“Seeing” | Visual-Inertial Motion Estimation

[Diagram showing the process of visual-inertial motion estimation]

https://www.youtube.com/watch?v=yvgPrZNp4So
Autonomous Navigation | flying in cluttered Environments

Forest Experiment 4 - 1x

https://www.youtube.com/watch?v=rAJwD2k7C0
Faculty (Tutors)

- Daniel Ahmed
- Raffaello D'Andrea
- Emilio Frazzoli
- Marco Hutter
- Robert Katzschmann
- Brad Nelson
- Salvador Pané
- Roland Siegwart
- Melanie Zeilinger
- Joachim Buhmann
- Stelian Coros
- Otmar Hilliges
- Christian Holz
- Andreas Krause
- Marc Pollefeys
- Siyu Tang
- Florian Dörfler
- Yu Fisher
- John Lygeros
- Roy Smith
- Luc van Gool
- Roger Gassert
- Robert Riener
- Simone Schürle
- Stefano Mintchev

Adjunct Faculty
- Gustavo Alonso
- Tobias Delbrück
- Markus Gross
- Johann Kolar
- Christopher Onder
- Davide Scaramuzza
- Olga Sorkine Hornung
- Lothar Thiele
Application for HS 2022

- Application windows:
  - April 1 – April 30, 2022
  - November 1 – December 15, 2022
- Specialized Master
  - Admission “sur dossier”
  - D-MAVT, D-INFK, D-ITET and D-HEST students are typically admitted if they have reasonable performance in their Bachelor
- ETH students have also to apply
  - No need of recommendation letters for ETH Bachelor students
  - No need of English test or GRE for ETH Bachelor students
  - Apply online:
    - https://master-robotics.ethz.ch/
    - For questions regarding the admission process:
    - ETH Admission Office: info@mavt.ethz.ch
D-MAVT Student Administration

ETH Zentrum
LEE K 208
Leontinstrasse 21
8092 Zurich
info@mavt.ethz.ch

Opening Hours during the semester:
Monday & Thursday
13:00 - 16:00
Tuesday, Wednesday, Friday
09:00 - 12:00

Dr. Maddalena Velonà
Lorena Luzi
Silvia Häfliger