Master of Science in Robotics, Systems and Control

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

https://master-robotics.ethz.ch/
Key Insights

• Across Engineering Disciplines
  – Extending your knowledge toward the other engineering disciplines and beyond
  – D-MAVT, D-INFK, D-ITET, D-HEST

• A Specialized Master
  – At the interface of four engineering disciplines

• Tutor-Based
  – You define with the help of your Tutor your individual program → it is your program

• Solving Today's most Pressing Challenges
  – Mobility, logistics, energy supply, environment, health care, information society, …
Interdisciplinary, exciting and highly demanded in industry

• Key Topics
  – **Systems Engineering**
    – design and optimization of products and systems
  – **Physical Modelling and Simulation**
  – **Optimization and Control**
  – **Perception, Graphics, Virtual Reality**
  – **Embedded and Distributed Computing**
  – **Artificial Intelligence & Machine Learning**
  – **Robotics**
    – design, modelling and control
  – **Challenging Applications**
    – mobility, logistics, sustainability, autonomous transportation, VR/AR, automated construction, smart farming, health care, search and rescue, …
Excellent Science is the Foundation for Innovation

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

- ETH, Switzerland
- EPFL, Switzerland
- University of Freiburg, Germany
- UniPisa/IIT, Italy
- Bielefeld University, Germany
- 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
ETH | a melting pot for robotics and control technology

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## Curriculum Structure

*Individual programme defined with the help of your tutor*

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<th>Category</th>
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| 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-GESS 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 Programme
  – 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
Application for HS 2021

- Application period: 01 March – 31 March 2021
- 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 for ETH Bachelor students
  - Apply online:
    - https://master-robotics.ethz.ch/
    - For questions regarding the admission process:
    - ETH Admission Office: info@mavt.ethz.ch
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
Next Generation of Robots
| mobile, smart, connected, adaptive and closer to humans

**Industrial Robots**
https://www.youtube.com/watch?v=Selq0Qy0oXjl

**Service Robots**
https://www.youtube.com/watch?v=tf7IEVTDjng
Walking Robot ANYmal | designed for challenging environments

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

https://www.youtube.com/watch?v=EI1zBTYpXW0

ETH Zürich
Roland Siegwart

Prof. Marco Hutter
ANYmal | combining dynamic motion skills with large mobility
ANYmal (ETH) learning robot locomotion in rough terrain

Adaptive Terrain Curriculum

Initialization  Iteration 500  Iteration 1000  Iteration 2500  Iteration 8000

https://youtu.be/knIzDj1Ocoo
Flying Robots | pushing the flight duration

**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
Flying Robots | an agility omnidirectional multicopter

- Goal:
  - Fly in all directions at any attitude of the main body
  - Generate forces in all directions

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

https://www.youtube.com/watch?v=yvgPrZNp4So
Deep Drone Racing

Kaufmann et al., *Deep Drone Racing*, CORL’18, Best System Paper Award. [PDF. Video.]

Kaufmann et al., *Beauty and the Beast: Optimal Methods Meet Learning for Drone Racing*, ICRA’19. [PDF. Video]

https://www.youtube.com/watch?v=UuQvijZcUSc&feature=youtu.be

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