Camera Drones
Lecture – Camera drones overview

Prof. Friedrich Fraundorfer

WS 2021
About me

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- Sprechstunde nach Vereinbarung
Course schedule

- See dates for lecture slots in TUG-Online
- Project work
  - Drone navigation practical
  - Presentation
  - Documentation

- Practical is group work (groups of three)
- Course grade will be based on the grades for the project work including documentation, project presentation and a questionnaire (60/10/30).
- Start of project work leads to grading of the course
- The project work is the partial course assignment that can be repeated or supplemented
- The course requires a significant amount of self-learning.
## Course schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Location</th>
<th>Session</th>
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<tbody>
<tr>
<td>06.10.2021</td>
<td></td>
<td>HS i9 (PZ2EG048)</td>
<td>Lecture Introduction</td>
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<td>13.10.2021</td>
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<td>Lecture: Flight mechanics</td>
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<td>Lecture: Sensors (continued)</td>
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<td>Lab introduction (individual groups)</td>
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<td>HS i9 (PZ2EG048)</td>
<td>ROS Tutorial (Live streaming with</td>
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<td>guest lecturer)</td>
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<td>Lecture: 3D data generation</td>
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<td>Lecture: Flight planning</td>
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<td>01.12.2021</td>
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<td>HS i9 (PZ2EG048)</td>
<td>Lecture: UAV Regulations</td>
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<td>HS i9 (PZ2EG048)</td>
<td>Practical 3 and 4 discussion</td>
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<td></td>
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<td></td>
<td>Seminarraum (IE02082)</td>
<td>Presentations</td>
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</table>
Practical part of the course
Course drone

- Ryze Tech Tello EDU (10x10 cm, 80g)
Course drone

Specifications:
- 5MP front camera
- 1080x720px video resolution
- 13min flight time
- Python interface for programming
- Vision Positioning System
  - Downward-looking camera
  - Infrared distance sensors
Lab infrastructure (droneSpace)
Tracking cameras
Practical 2021 – Collision free navigation
Main tasks:

1. Mapping of the environment
   - Create Octomap from sensor input such that it provides a 3D map for path planning.

2. Path planning for safe navigation
   - Implement a path planning algorithm to navigate the drone collision-free to a goal position (e.g. RRT algorithm)

3. Trajectory generation and flight
   - Perform flight and videotape it
Task 1: Mapping of the environment

- Octomap creation from ROS-Bag
Task 2: Path planning
Task 3: Trajectory generation and flight

MAV trajectory generation
- Smooth trajectory from path
- Impose position derivatives (speed, acceleration, jerk, snap)
Camera drones overview
Camera drones overview

- Consumer drones

- Professional drones

- Research drones
Consumer drones – The First

[Image credit: Parrot]
Consumer drones

[Image credit: DJI]

[Image credit: Yuneec]

[Image credit: GoPro]

[Image credit: Parrot]
Consumer drones – The most advanced

- Skydio 2
Professional drones

- Asctec Falcon
- Aerial photography and inspection

[Image credit: Asctec]
Professional drones

- Leica/Aibotix drone
- Inspection and measurement tasks
Professional drones

- Riegl Ricopter
- Photogrammetry and Laser scanning
- 25kg!

[Image credit: Riegl]
Professional drones

- Flyability drone
- Indoor inspection

[Image credit: Flyability]
Professional drones

- Honeywell RQ-16 T-Hawk
- Reconnaissance, long endurance drone
Professional drones

- Schiebel Camcopter
- Industrial inspection, long endurance drone

[Image credit: By User:Stahlkocher, CC BY-SA 3.0]
Professional drones

- Sensefly Ebee
- Fixed wing, long endurance
- Photogrammetry
Professional drones

- Swarmsys Nano-Drone
- Reconnaissance

[Image credit: Swarmsys]
Research drone

- Pixhawk drone
- Modular research platform with onboard computer and cameras
Research drone

- Asctec Firefly
- Modular research platform with onboard computer and cameras
Research drone

- DJI Matrice 100
- Modular research platform with onboard computer and cameras
- Onboard stereo depth sensors
Drone highlight – Mars helicopter

**BLADES**
Made of carbon fiber foam core provide lift in the thin Mars atmosphere.

**ANTENNAS**
Radio antennas talk to Earth via the Mars 2020 rover and the Mars orbiters.

**SOLAR PANEL**
A solar panel helps keep the battery charged.

**BATTERIES**
Batteries help power the helicopter.

**SENSORS & CAMERAS**
Sensors collect data on how fast the helicopter is travelling and in which direction. Cameras help the helicopter see.

**AVIONICS & BODY**
Its avionics — or "brains" — help the helicopter function and navigate. The body has insulation and heaters to keep sensitive electronics warm and survive cold Martian nights.
## Technical specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Mass</strong></td>
<td>1.8 kilograms</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>4 pounds on Earth; 1.5 pounds on Mars</td>
</tr>
<tr>
<td><strong>Width</strong></td>
<td>Total length of rotors: ~4 feet (~1.2 meters) tip to tip</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>Solar panel charges Lithium-ion batteries, providing enough energy for one 90-second flight per Martian day (~350 Watts of average power during flight)</td>
</tr>
<tr>
<td><strong>Blade span</strong></td>
<td>Just under 4 feet (1.2 meters)</td>
</tr>
<tr>
<td><strong>Flight range</strong></td>
<td>Up to 980 feet (300 meters)</td>
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<tr>
<td><strong>Flight altitude</strong></td>
<td>Up to 15 feet (5 meters)</td>
</tr>
<tr>
<td><strong>Flight environment</strong></td>
<td>Thin atmosphere, less than 1% as dense as Earth's</td>
</tr>
</tbody>
</table>
The real size
A picture from first flight
Camera drone applications and research

- Action filming
- Archeology ([3D Pitoti, 3D Model](#))
- Inspection (Bridges, Power pylons)
- Search and Rescue ([DJI Challenge](#))
- Agriculture
- Safe navigation ([Video](#))
- Autonomous exploration ([Video](#))
- Human-Robot Interaction ([Video](#))
- Delivery ([Video](#))
- Industrial application ([Video](#))
Past student projects

- "Don’t Throw Things At Drones!"
- "Optitrack & RGBD-Sensor Based Indoor Mapping"
- "Hand-Gesture Based Drone Control"
- "Visual Marker Following Drone"
- "Hula Hoop Following Drone"
- "ORB2 SLAM Based Indoor Reconstruction"
- "Snapdragon Flight Based Object Recognition And Waypoint Following"