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

06.10.2021	HS i9 (PZ2EG048)	Lecture Introduction
13.10.2021	HS i9 (PZ2EG048)	Lecture: Flight mechanics Lecture : Sensors
20.10.2021	HS i9 (PZ2EG048)	Lab introduction
		Practical 1 discussion
		Lecture: Sensors (continued)
22.10.2021	Dronespace	Lab introduction (individual groups)
27.10.2021	Webex	ROS Tutorial (Live streaming with guest lecturer)
03.11.2021	HS i9 (PZ2EG048)	Lecture: 3D data generation
10.11.2021	HS i9 (PZ2EG048)	Practical 2 discussion
		Lecture: Flight planning
17.11.2021	HS i9 (PZ2EG048)	Lecture: UAV Regulations
24.11.2021	HS i9 (PZ2EG048)	Practical 3 and 4 discussion
01.12.2021	HS i9 (PZ2EG048)	No lecture / Discussion on request
15.12.2021	HS i9 (PZ2EG048)	No lecture / Discussion on request
12.01.2022	Seminarraum (IE02082)	No lecture / Discussion on request
12.01.2022	HS i5 (MD01160F)	Quizz
19.01.2022	Seminarraum (IE02082)	Presentations
26.01.2022	Seminarraum (IE02082)	Presentations

Practical part of the course

Course drone

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

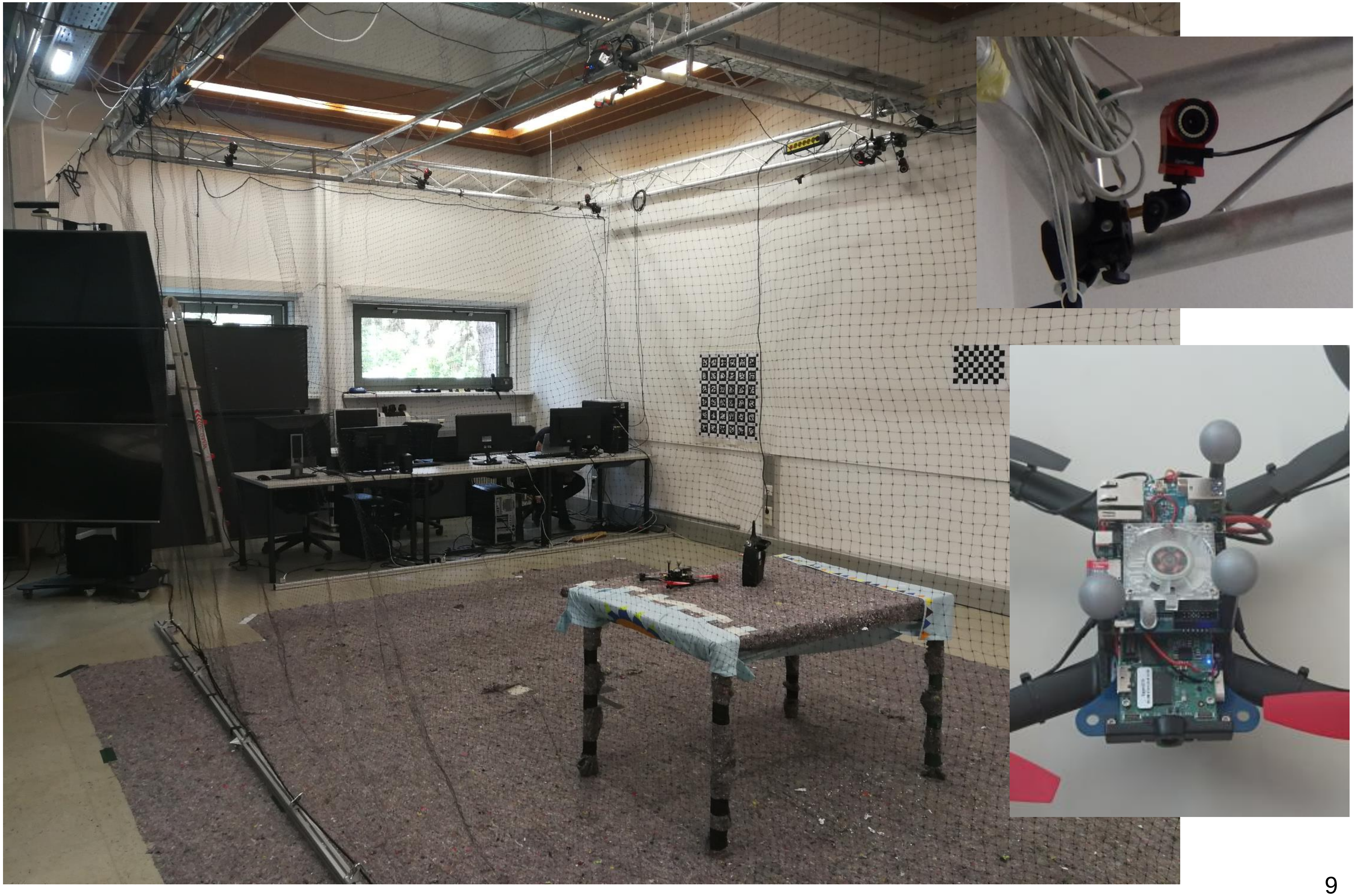
Course drone

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

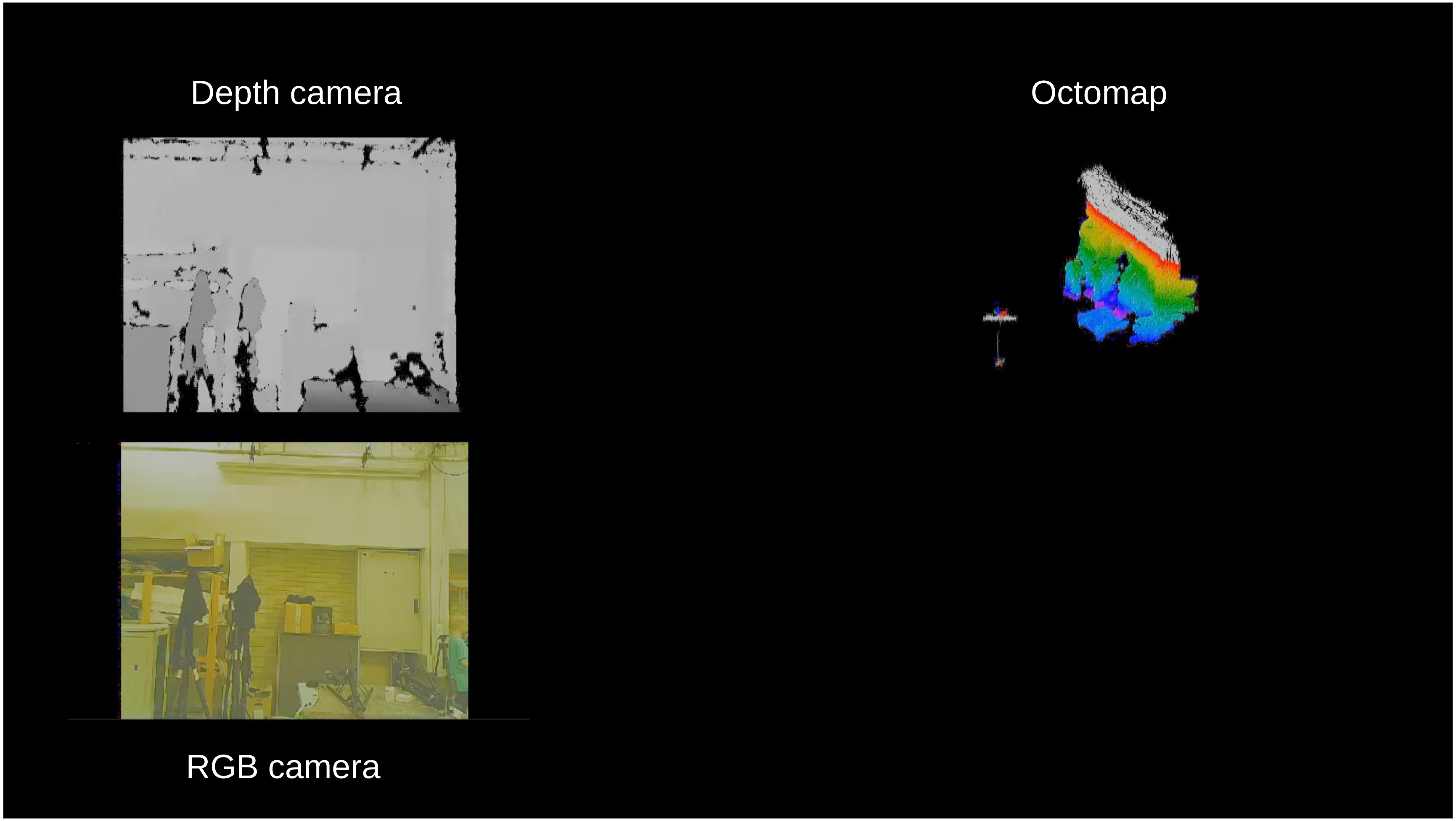
Practical 2021 - Collision free navigation

Main tasks:

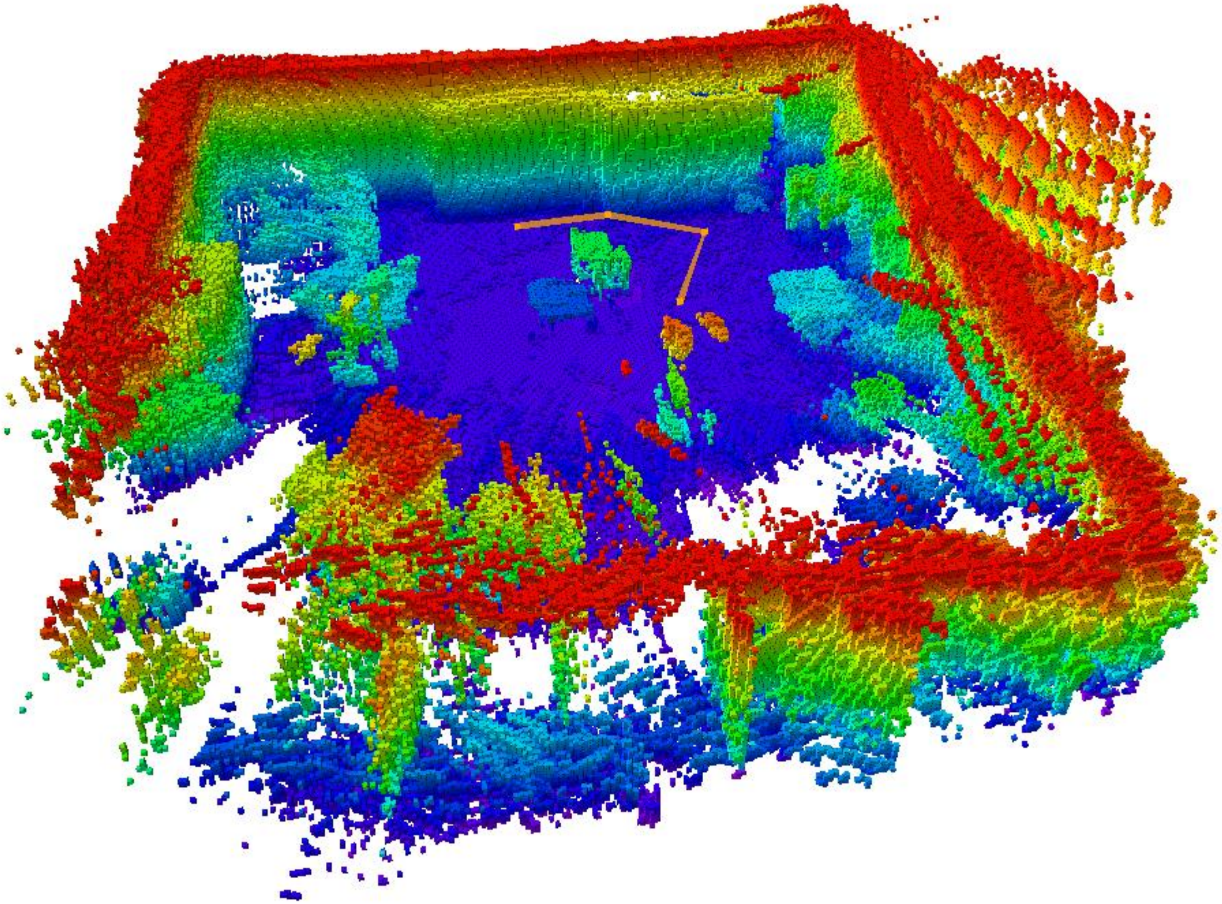
- 1. Mapping of the environment
  - Create Octomap from sensor input such that it provides a 3D map for path planning.
- 2. Path planning for safe navigation
  - Implement a path planning algorithm to navigate the drone collision-free to a goal position (e.g. RRT algorithm)
- 3. Trajectory generation and flight
  - Perform flight and videotape it

Task 1: Mapping of the environment

- Octomap creation from ROS-Bag



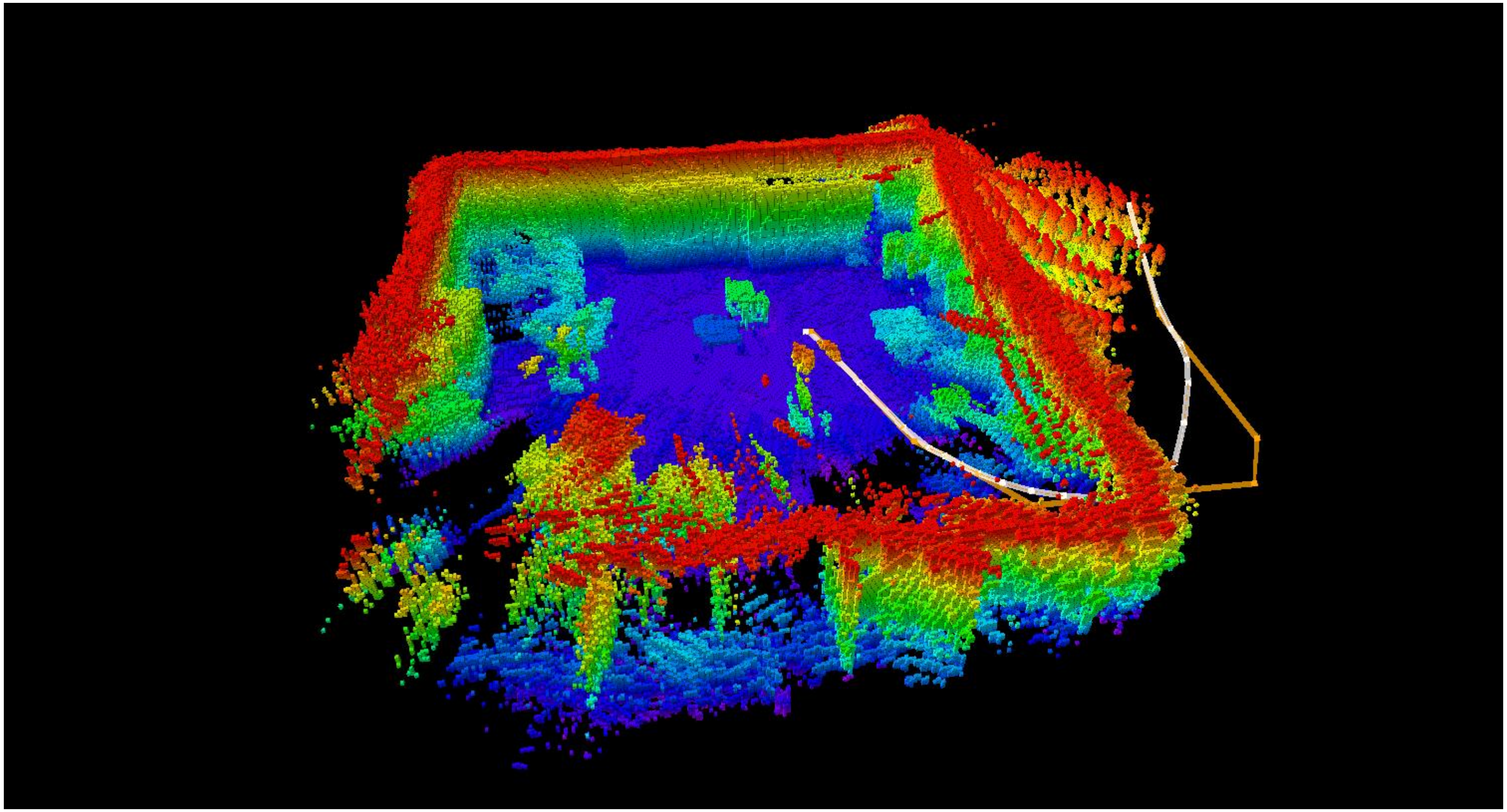
Task 2: Path planning



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

[Image credit: DJI]

- Professional drones

[Image credit: Leica]

- 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

[Image credit:Skydio

Professional drones

- Asctec Falcon
- Aerial photography and inspection

[Image credit: Asctec]

Professional drones

- Leica/Aibotix drone
- Inspection and measurement tasks

[Image credit: Leica]

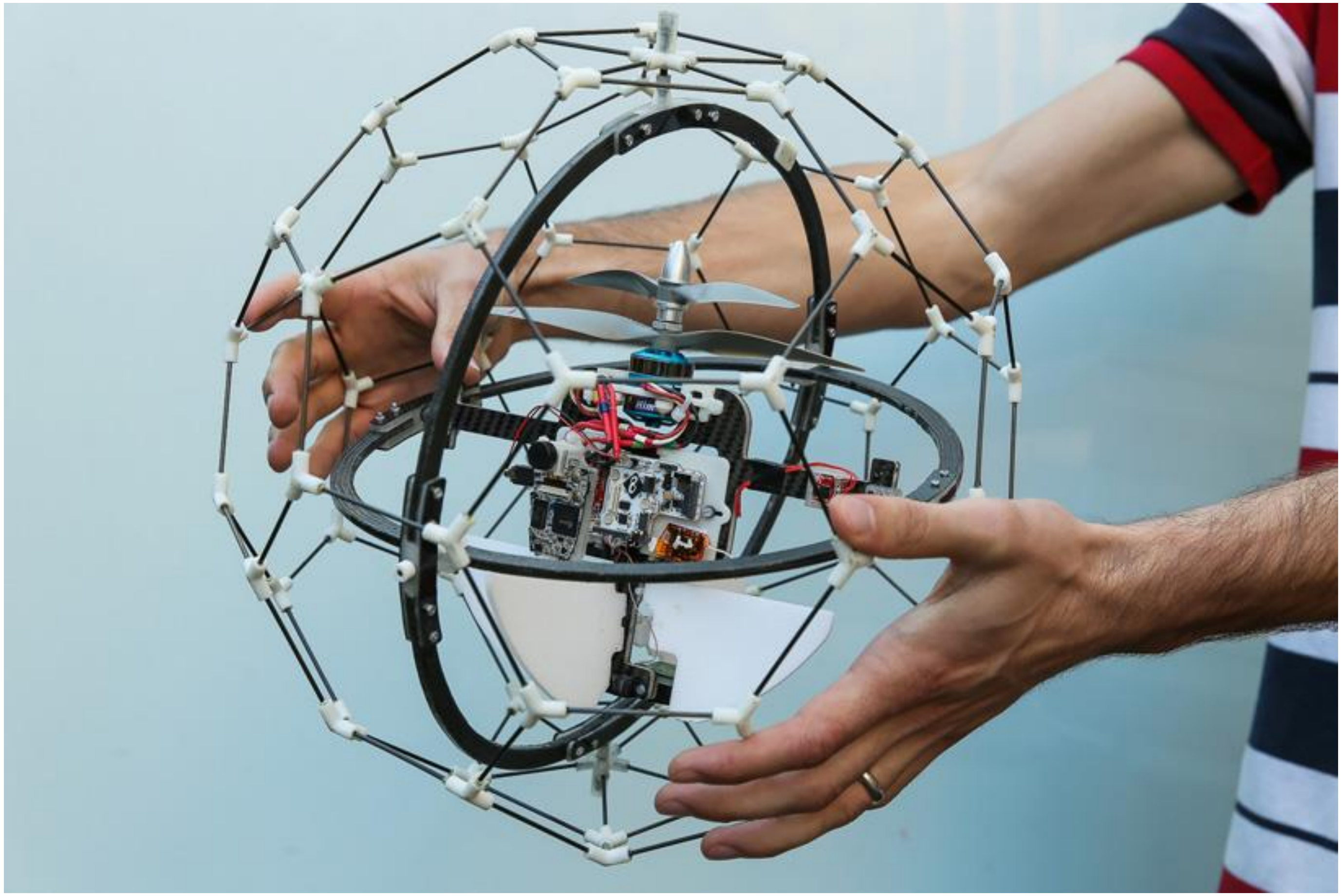
Professional drones

- 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

[Image credit: Wikipedia]

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

[Image credit: Sensefly]

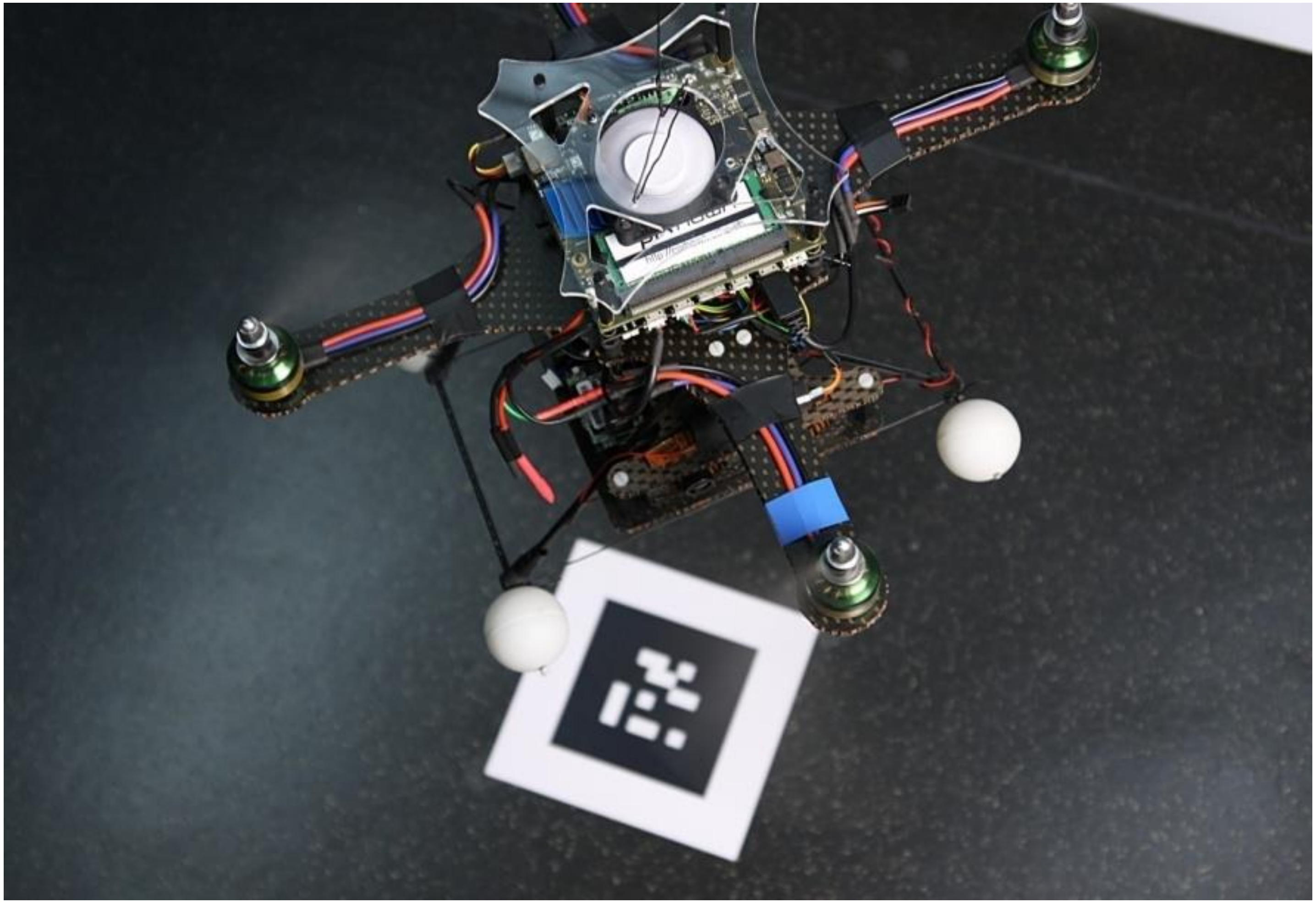
Professional drones

- Swarmsys Nano-Drone
- Reconnaissance

[Image credit: Swarmsys

Research drone

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

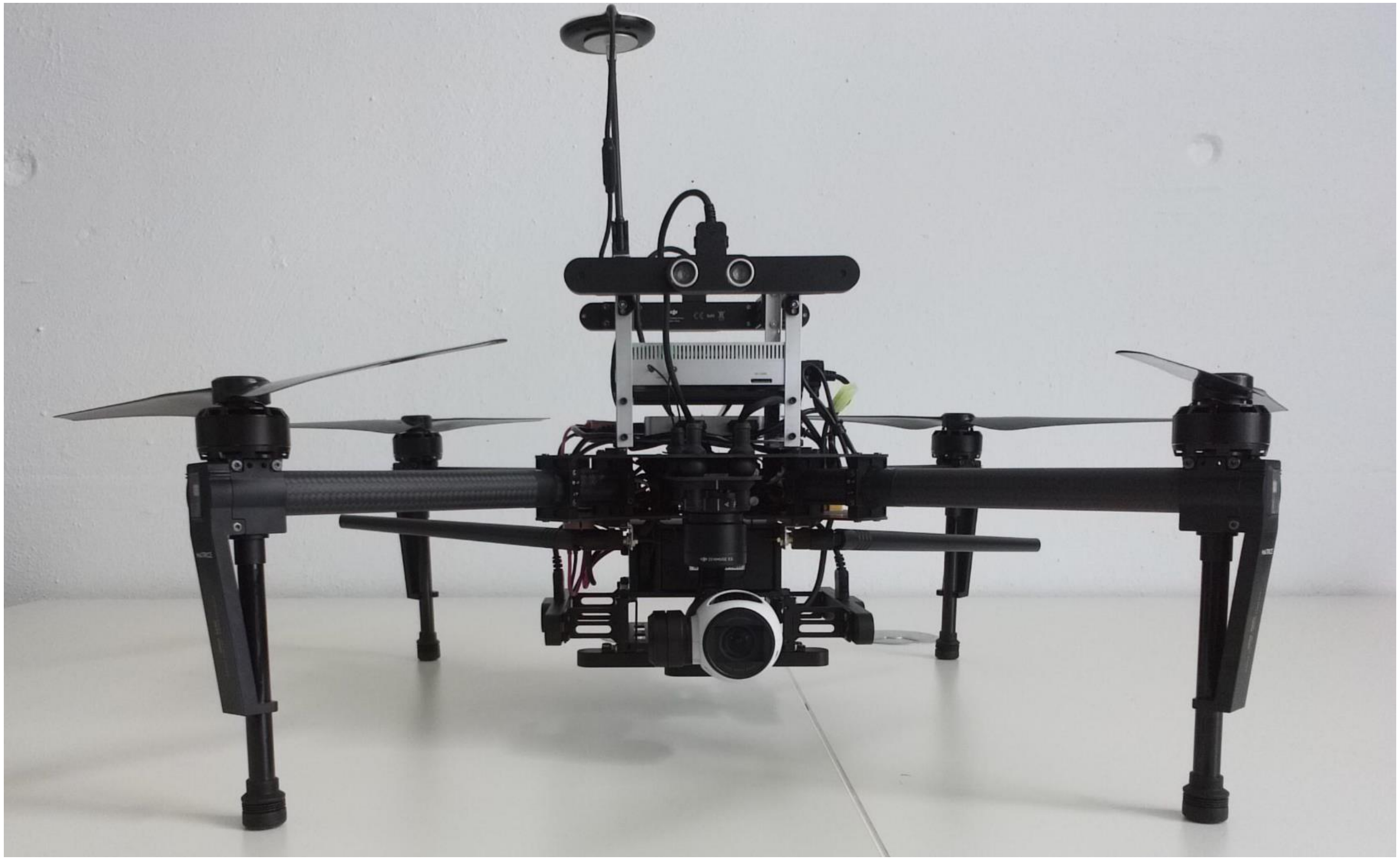


Research drone

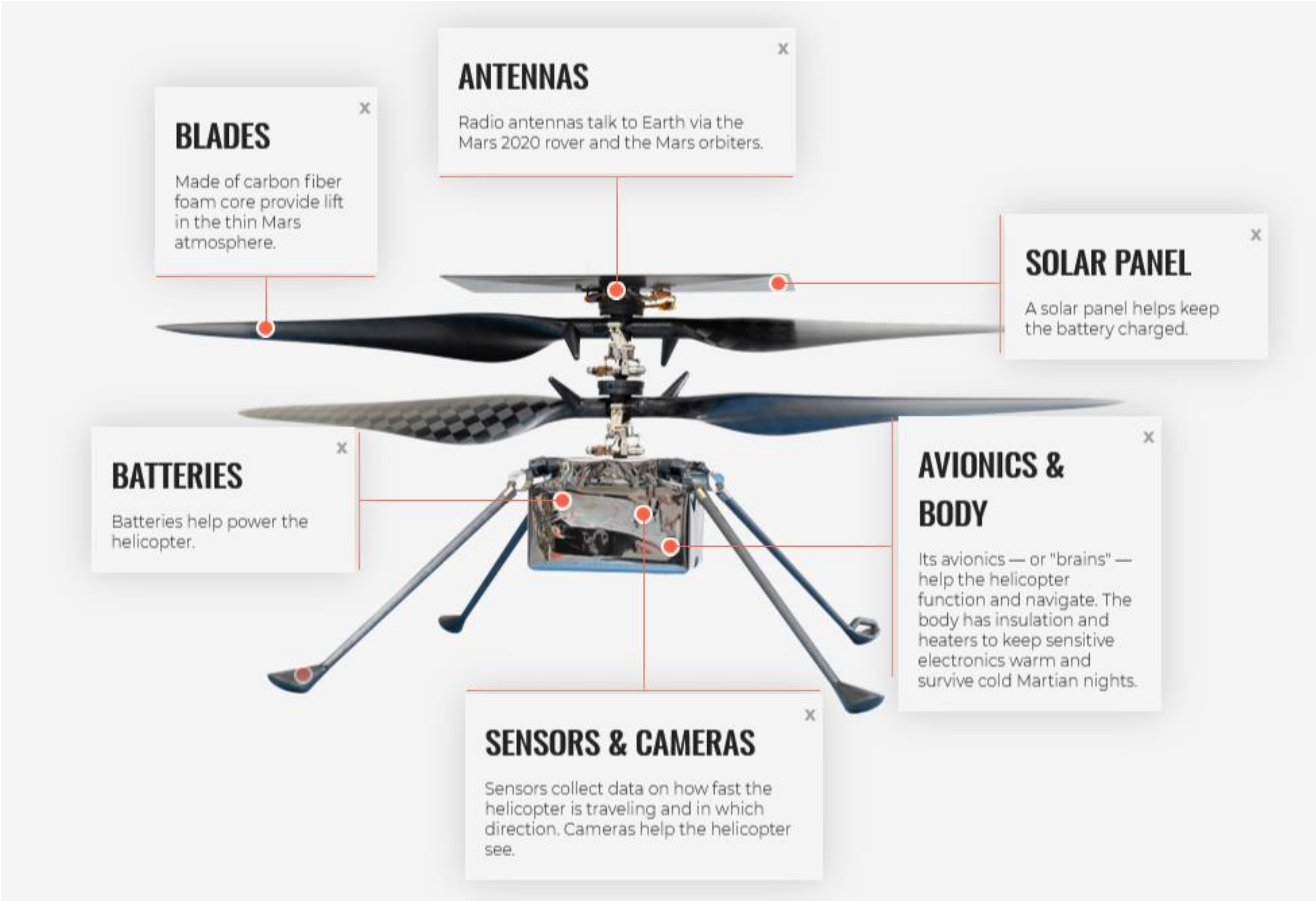
- Asctec Firefly
- Modular research platform with onboard computer and cameras

Research drone

- DJI Matrice 100
- Modular research platform with onboard computer and cameras
- Onboard stereo depth sensors



Drone highlight – Mars helicopter



Technical specifications

Mass	1.8 kilograms
Weight	4 pounds on Earth; 1.5 pounds on Mars
Width	Total length of rotors: ~4 feet (~1.2 meters) tip to tip
Power	Solar panel charges Lithium-ion batteries, providing enough energy for one 90-second flight per Martian day (~350 Watts of average power during flight)
Blade span	Just under 4 feet (1.2 meters)
Flight range	Up to 980 feet (300 meters)
Flight altitude	Up to 15 feet (5 meters)
Flight environment	Thin atmosphere, less than 1% as dense as Earth's

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"