Camera Drones
Lecture – Camera drones overview

Prof. Friedrich Fraundorfer

WS 2024

Lecture contact

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Practical contact

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- TC Forum

Course schedule

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

- Practical is group work (groups of two)
- 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 course requires a significant amount of self-learning.

Course schedule

09.10.2024	HS I9	Lecture: Introduction lecture Introduction to practical
16.10.2024	HS i9	Lecture: Flight mechanics Dronespace introduction
23.10.2024	HS i9	Lecture: ROS Part 1, Practical Handout
25.10.2024	droneSpace	droneSpace introduction (individual groups)
30.10.2024	HS i9	Lecture: ROS Part 2
06.11.2024	HS i9	Lecture: Sensors
13.11.2024	HS i9	Lecture: Sensors Lecture: Sensor fusion
20.11.2024	HS i9	Lecture: 3D data generation
27.11.2024	HS i9	Lecture: Flight planning
04.12.2024	HS i9	Lecture: UAV Regulations
18.12.2024	HS i9	No lecture
08.01.2025	HS i9	Q&A session
15.01.2025	HS i9	Quiz
16.1.2025	droneSpace	Testing hours
17.1.2025	droneSpace	Testing hours
22.01.2025	HS i9	No lecture
29.1.2025	HS i9	No lecture
31.01.2025	droneSpace	Flight presentations (whole day)

Practical schedule:

- 23.10.2024: Practical handout
- 16.12.2024/6.1.2025: Interim feedback dates
- 22.1.2025: Final submission deadline

Practical part of the course

Course drone

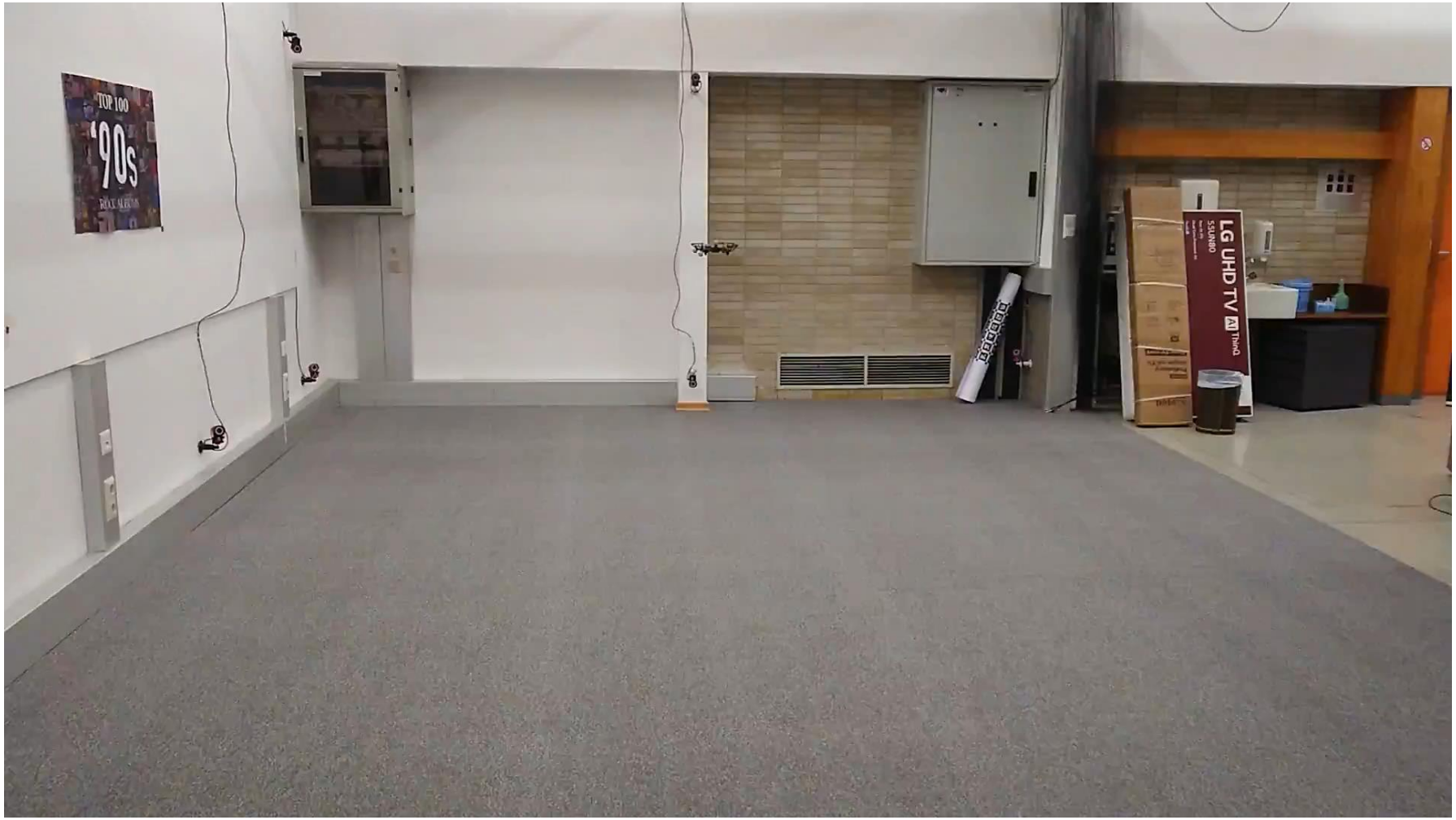
- Ryze Tech Tello EDU (10x10 cm, 80g)

Course drone

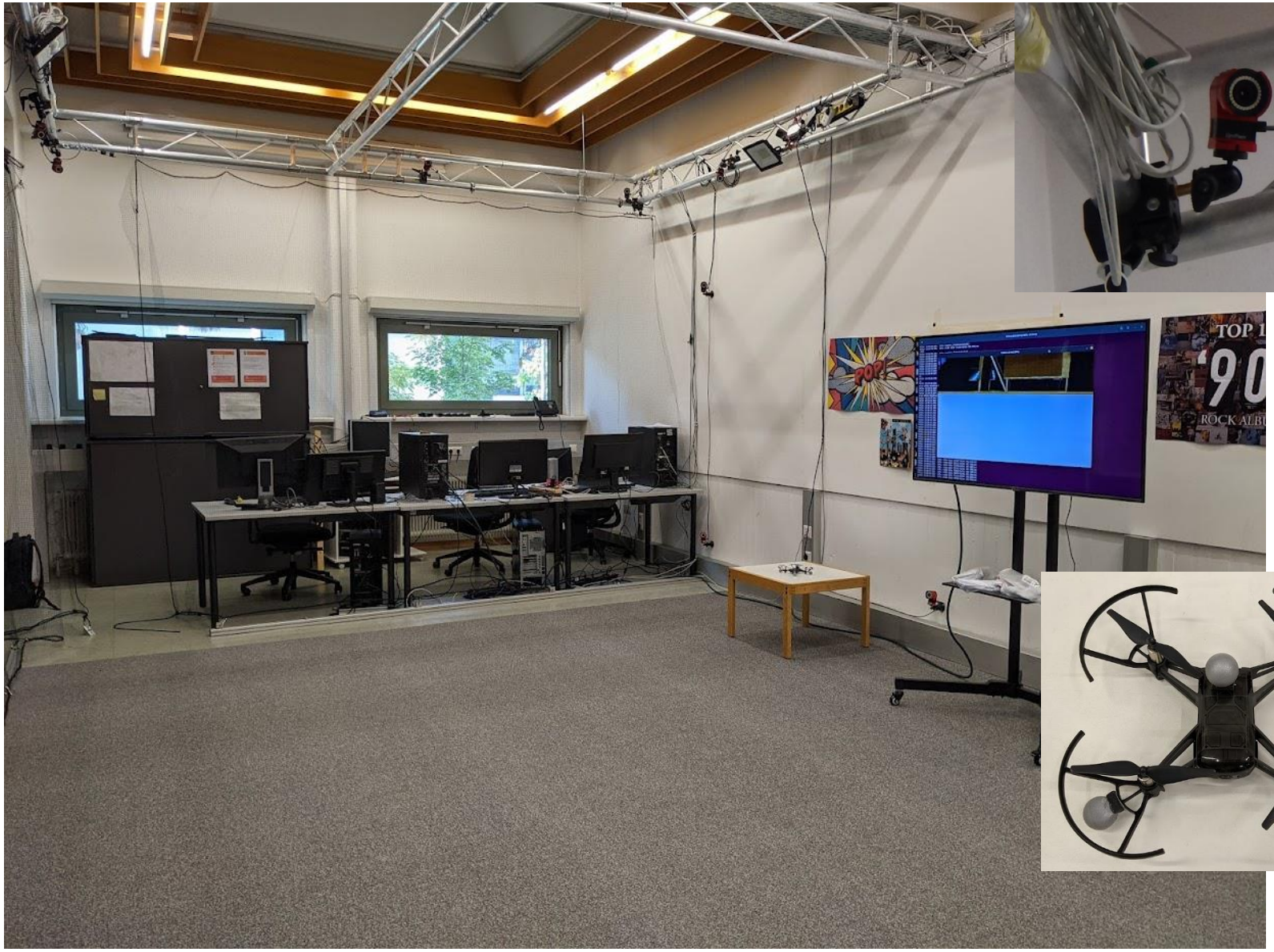
Specifications:

- 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)

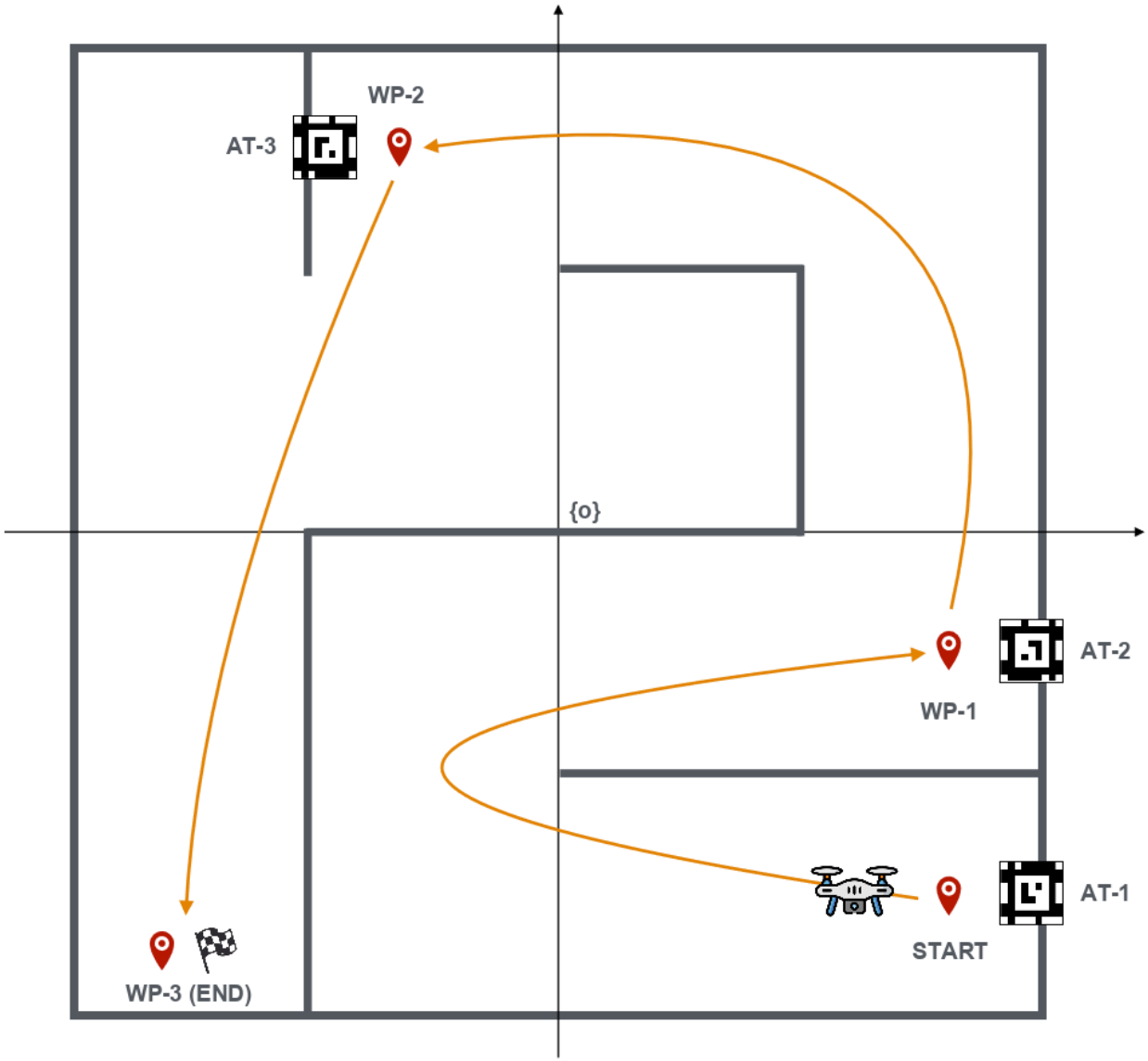


Tracking cameras



Navigation example

Practical – Maze runner



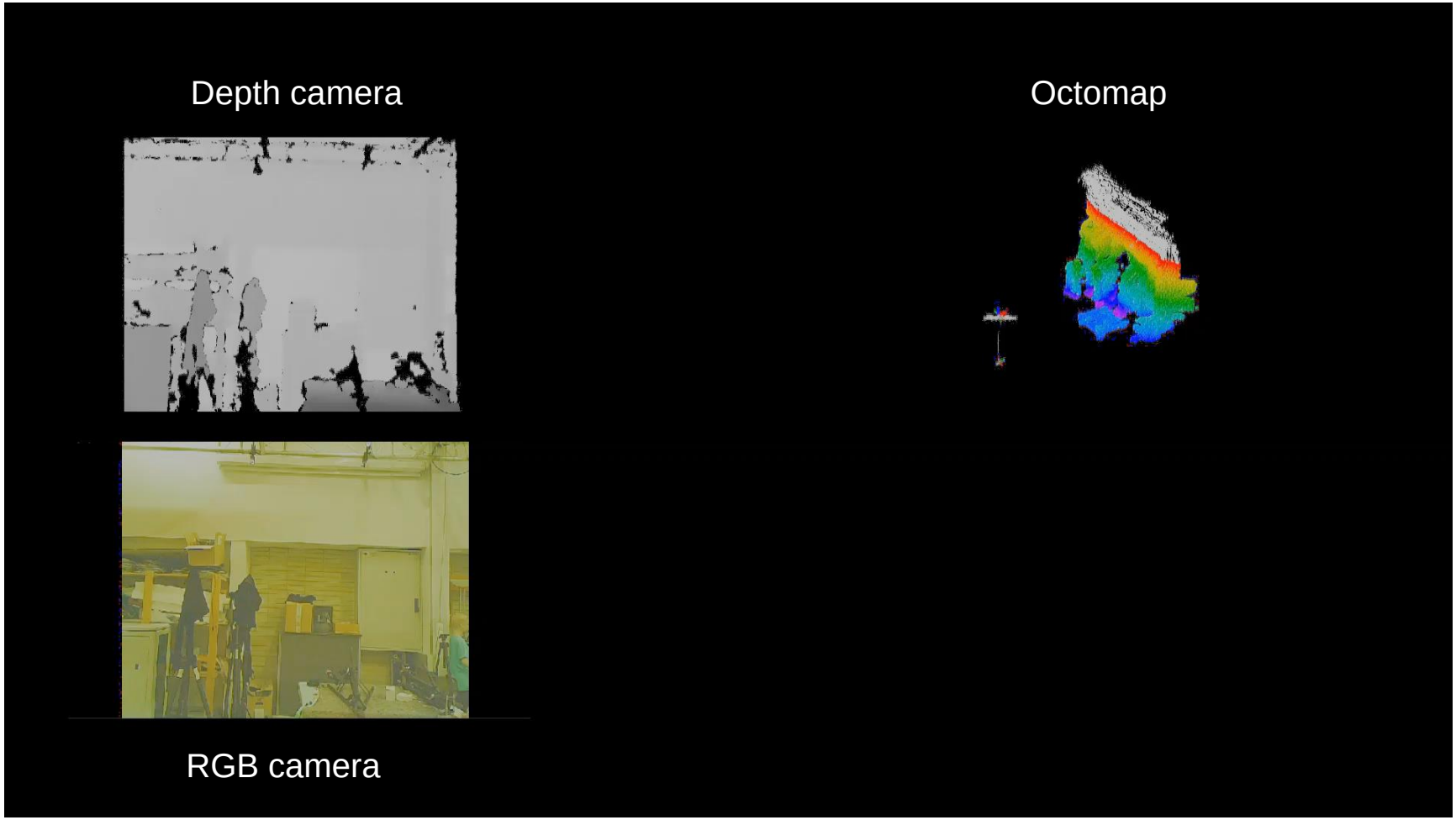
Practical 2024 – Maze runner

4 contiguous assignments:

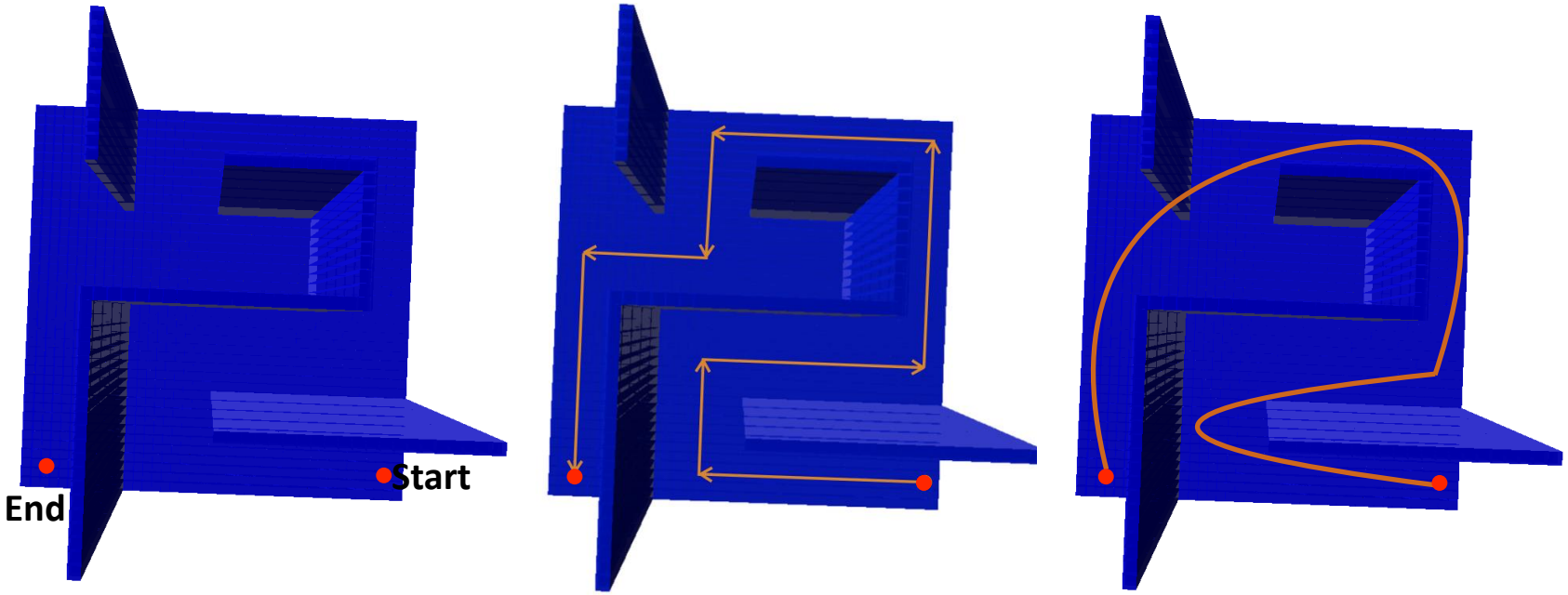
- 1. Mapping of the environment
  - Create Octomap from sensor input such that it provides a 3D map for path planning.
- 2. Trajectory planning for safe navigation
  - Calculate a collision-free trajectory to a goal position within a 3D map and have the drone fly the trajectory
- 3. Camera based drone pose estimation
  - Estimate the drone pose from images of an AprilTag marker
- 4. Navigating the maze
  - Follow breadcrumbs made of Apriltags to exit the maze.

Practical Assignment #1: Mapping of the environment

- Octomap creation from ROS-Bag



Practical Assignment # 2: Trajectory planning for safe navigation



Maze octomap*

Plan

Smooth

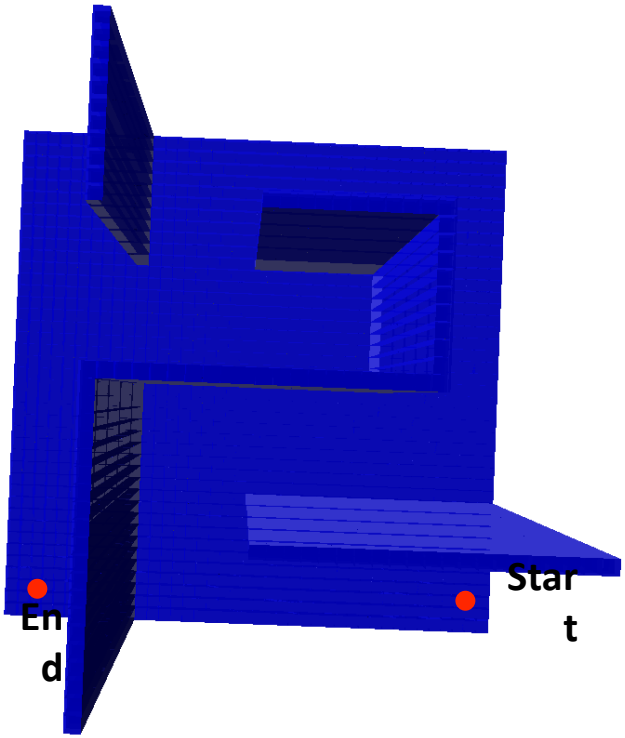
*: the outer walls and ceiling are removed for better demonstration

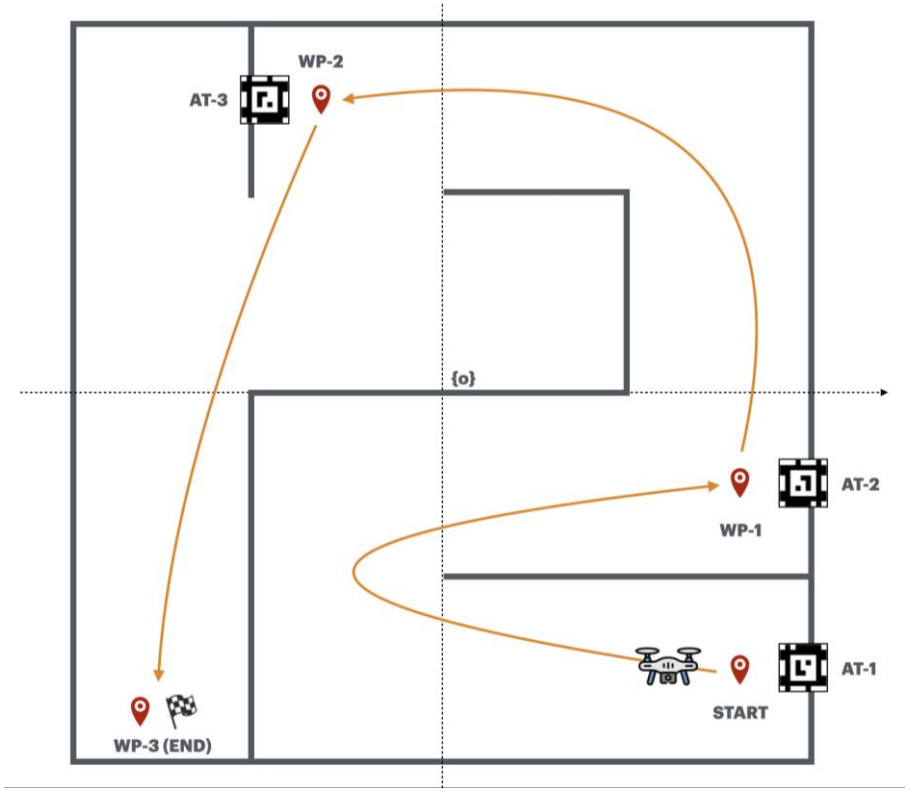
Practical Assignment # 3: Camera based drone pose estimation

Detect AprilTag markers in a ROS-Bag and estimate the drone pose from it

Practical Assignment # 4: Navigating the maze

- Navigate from Apriltag to Apriltag and plan and fly trajectories to exit the maze.





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:GoPro]

[Image credit: Parrot]

Consumer drones – The most advanced

- Skydio 2

[Image credit:Skydio

Consumer drones – The most fun

- DJI FPV

[Image credit: DJI]

Professional drones

- DJI Matrice 300 RTK
- Aerial photography and inspection

[Image credit: DJI]

Professional drones

- Leica/Aibotix drone
- Inspection and measurement tasks

[Image credit: Leica]

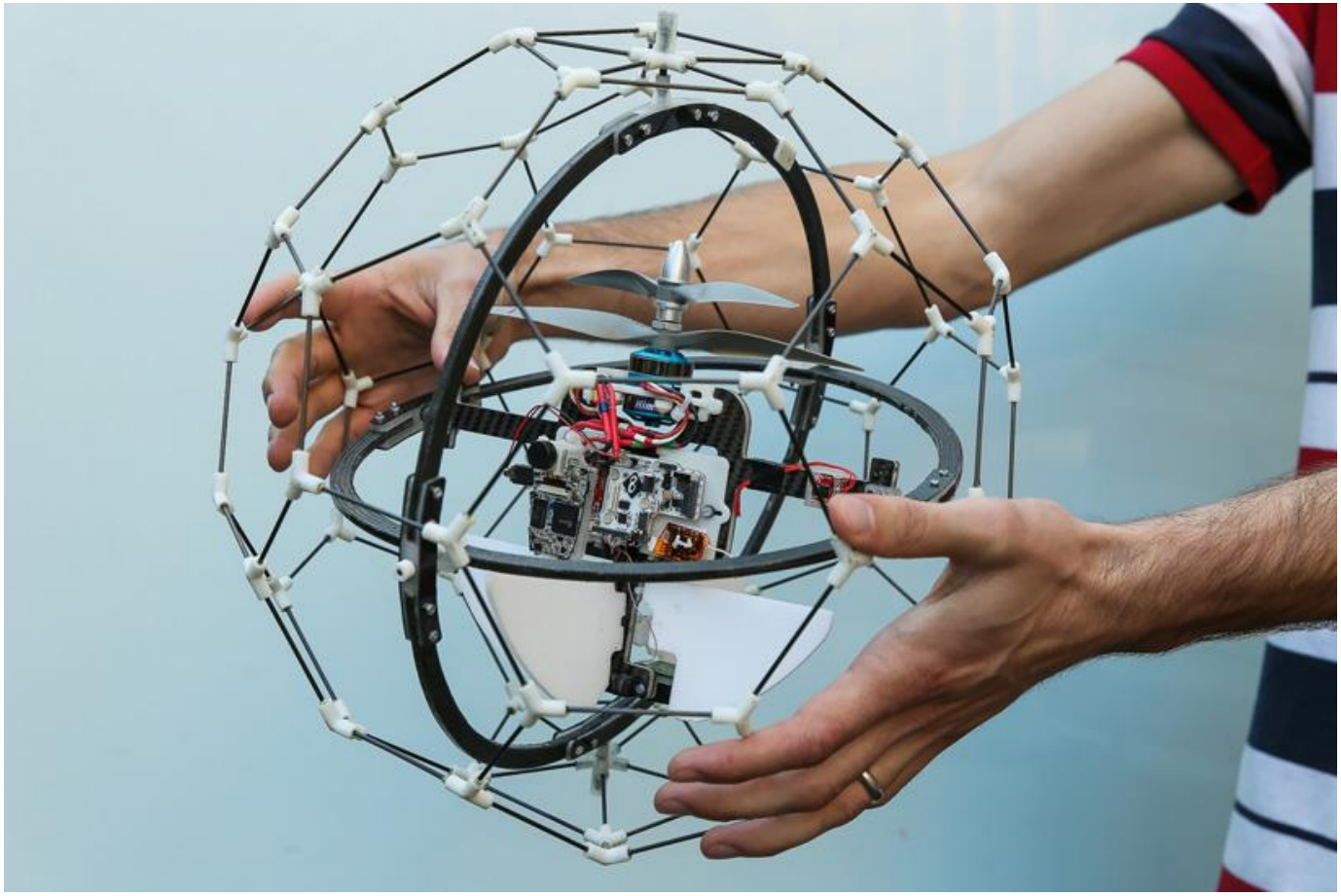
Professional drones

- 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]

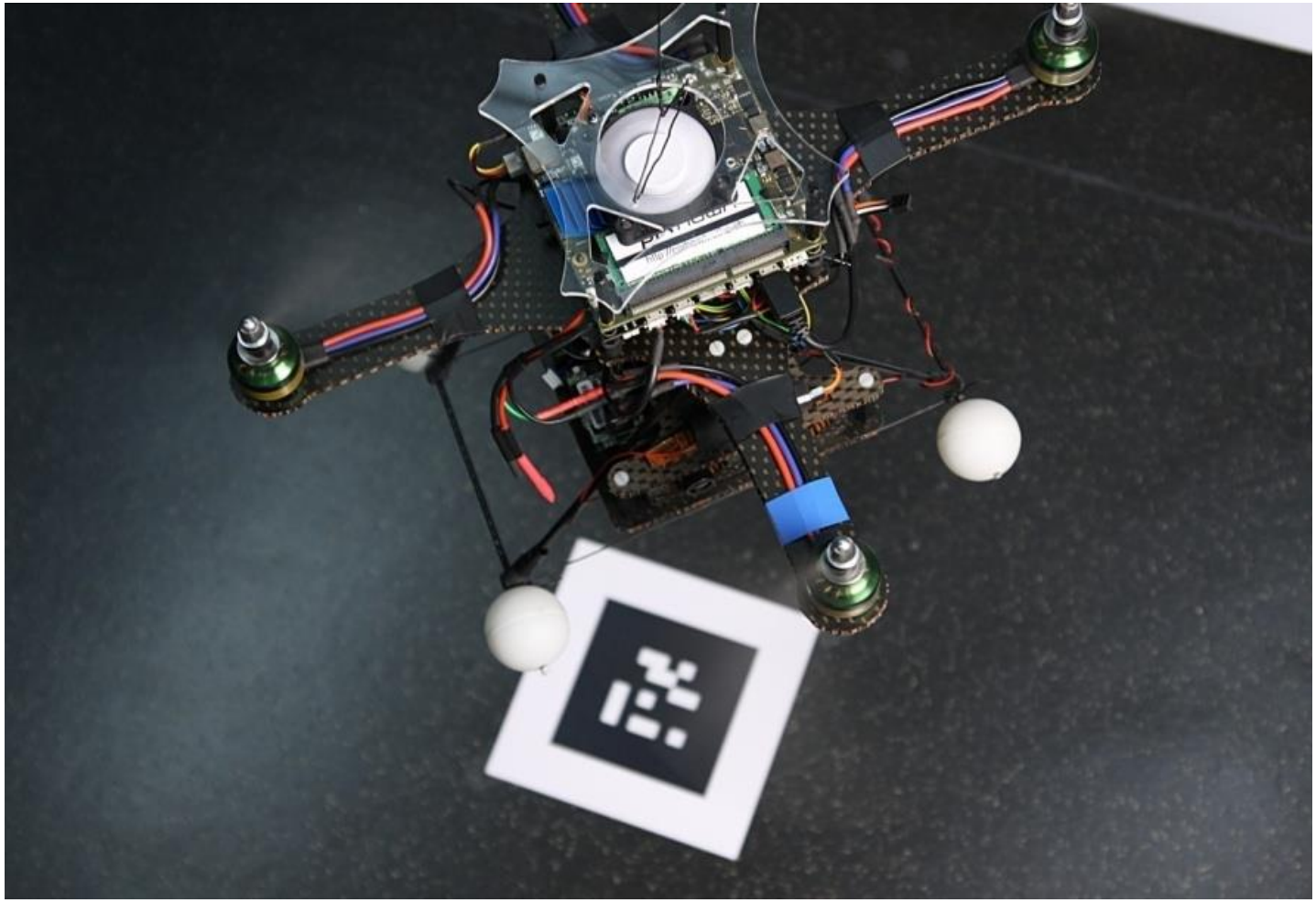
Professional drones

- Flir Nano-Drone
- Reconnaissance

[Image credit: Flir]

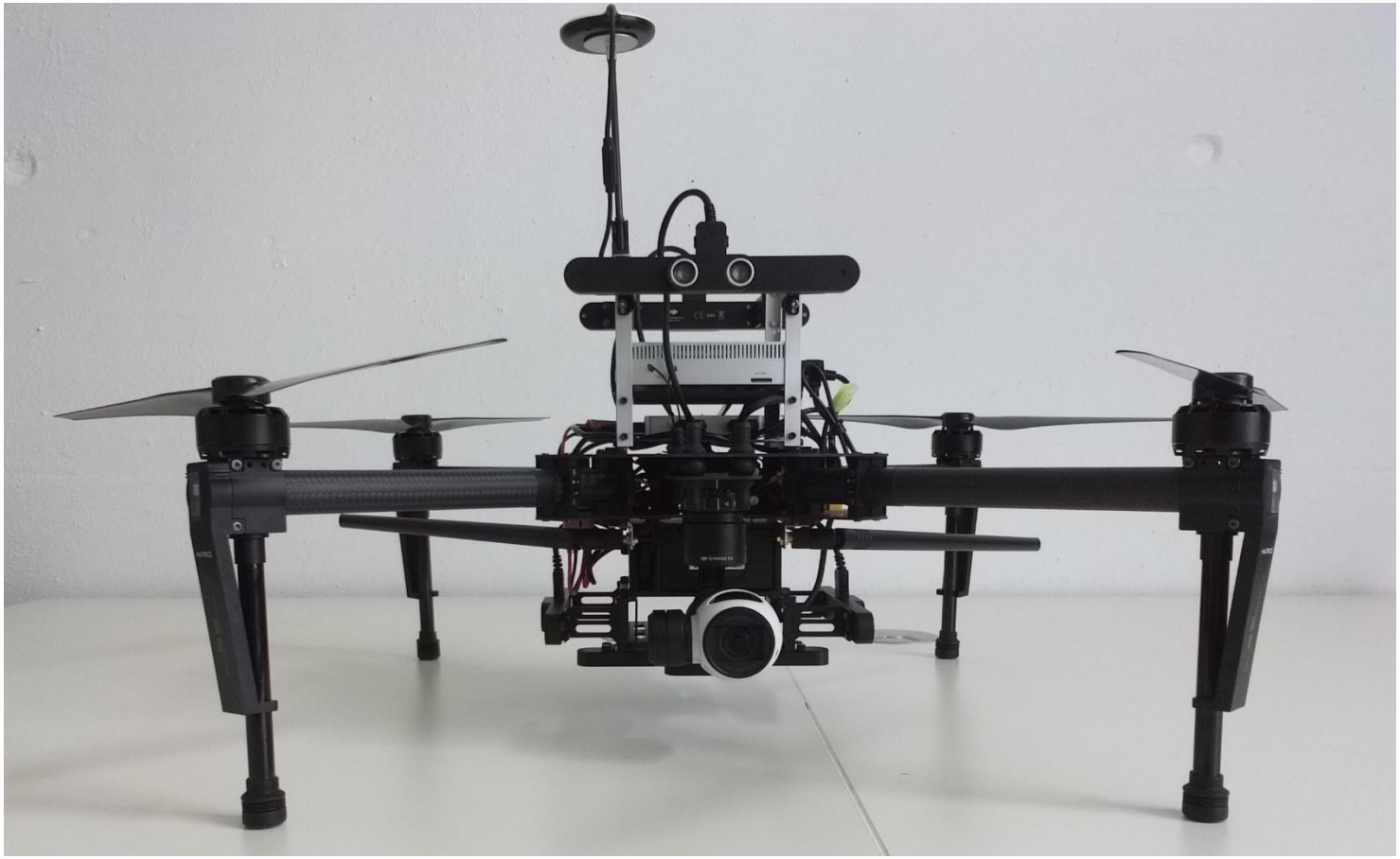
Research drone

- Pixhawk drone
- 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



Research drone

- Fly4Future F4F Robofly
- Modular research platform with onboard computer and cameras
- 855g weight, 11min flight time

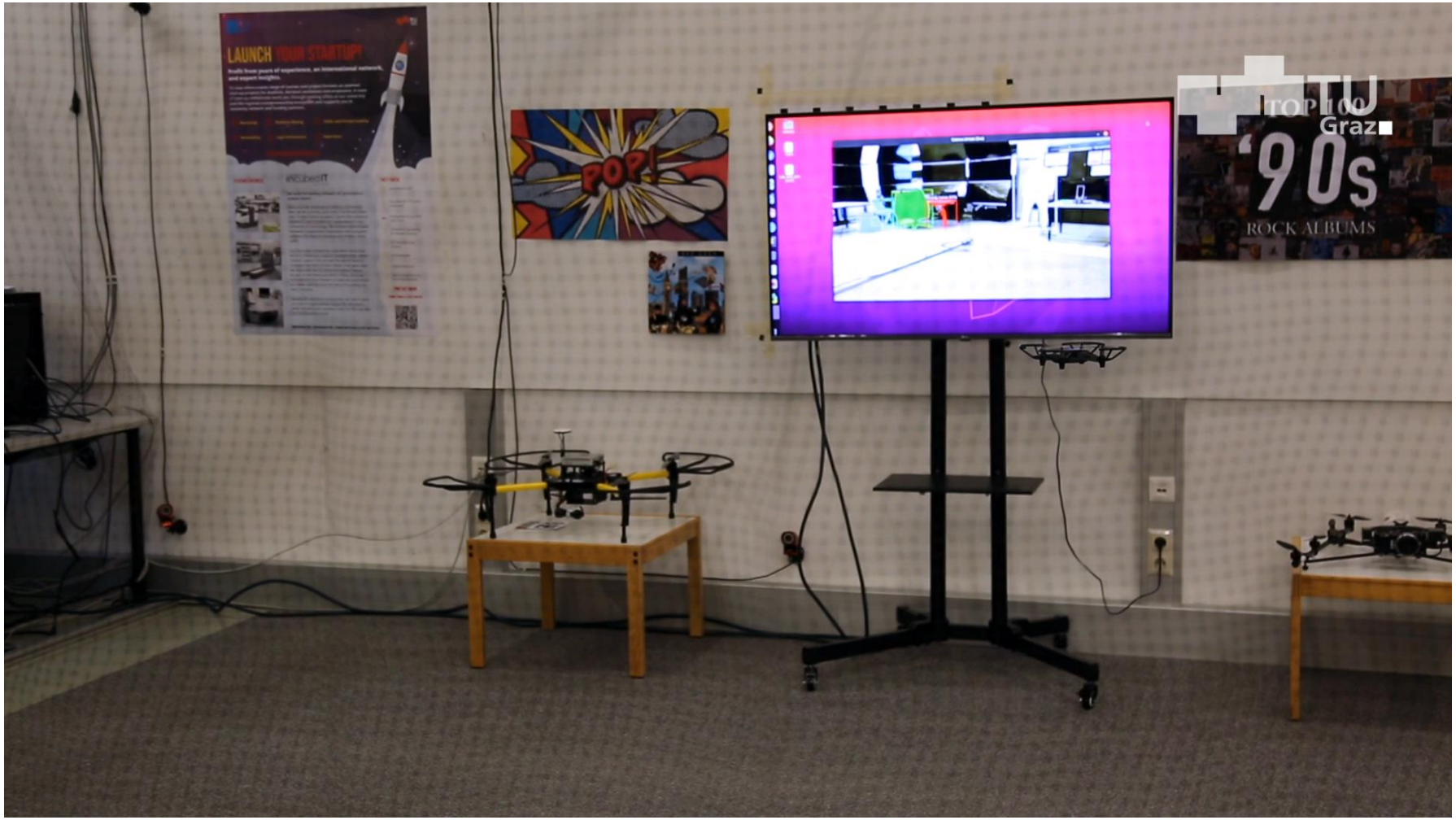
Resist project: Camera drones for bridge inspection

Resist project: Camera drones for bridge inspection

Camera drone applications and research

- Action filming
- Archeology (3D Pitoti, 3D Model)
- Inspection (Bridges, Power pylons)
- Search and Rescue (DJI Challenge)
- Agriculture
- Safe navigation
- Autonomous exploration
- Human-Robot Interaction
- Delivery (Video)
- Inventory drone (Video)

Student project



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"