AI Drones in Research and Education

Experiences, Challenges and Opportunities

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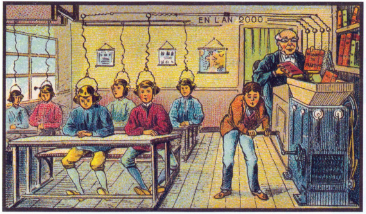
Motivation and Challenges

Purpose of this Talk

This talk summarizes the experiences, challenges and lessons learned from three semesters of teaching AI drones in a Master's project-based course at a University of Applied Sciences

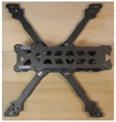
`https://www.christianbaun.de/Master_Projekt_SS2026/index_en.html`



At School

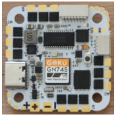
- Current state of the art:
  1. Drones are widely used in many applications worldwide
  2. AI enables additional application areas for autonomous drones and creates new opportunities across many disciplines
- **Universities of Applied Sciences should actively integrate AI drones into their curricula**
- However, this also brings many challenges
- AI drones are not well suited for a *traditional* lecture course
- The technology is complex and must be *experienced* in a hands-on course
- An ideal topic for a project-based course

Getting Started with the Topic – Challenging

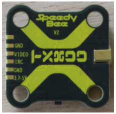


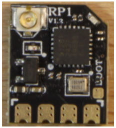



- Building AI drones requires expertise in hardware, firmware, regulations, and AI at the same time.
- Books on drones become outdated rapidly
- Laws and regulations are modified frequently
- Components are typically available for only a few months
- Numerous hardware components must be selected. They must be compatible and fit the intended application scenario
  - **Frame**, **Flight Controller**, **Motors**, **Propellers**, **Batteries**, **GPS/Compass**, **Optical Flow Sensors**, **LiDAR Rangefinders**, **Radio Transmitter and Receiver**, **Video Transmitter**, **Camera**, **Goggles**, **Firmware**
  - And then there is the AI part. . .
    - Which AI functions should be implemented?
    - Which sensor data is needed?
    - Which hardware and software are required?
    - Where will the hardware and software be located?
- The path: reading, research, experimentation, learning. . .
  - The cost: **time** and **money** (💰💸)
- Helpful in such a situation $\Longrightarrow$ see Slide 11

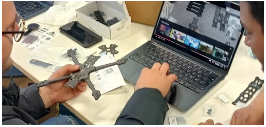
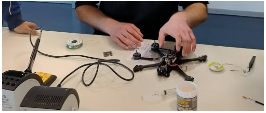
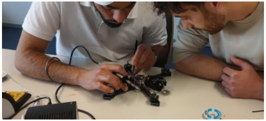
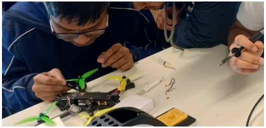
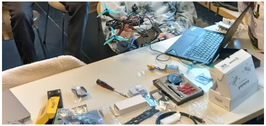








Lessons Learned from the 1st Run (Summer 2025)

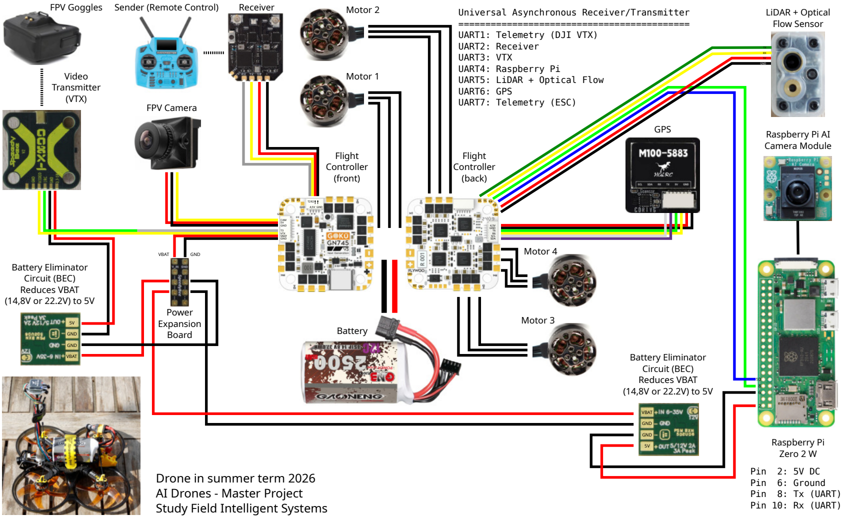






- Having students build AI drones from scratch takes too much time
  - Component acquisition, logistics and soldering skills are major challenges
- **Pre-built drones allow a stronger focus on AI**
- Many students are concerned about flying outdoors
  - Regulatory requirements are primarily relevant for outdoor flights
  - A sports hall is helpful
- Autopilot software (INAV, ArduPilot, PX4) requires powerful flight controllers (F745, H743. . .)
- Loose wires and components always find their way into propellers
- LiPo batteries dangerous
  - A better choice: Li-Ion batteries



AI Deployment (1/2)

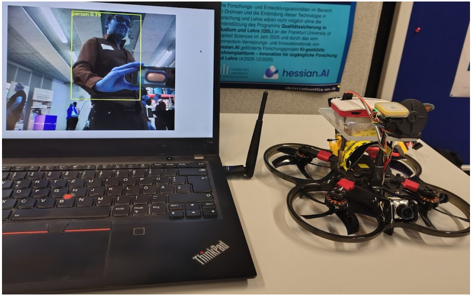
- Implementing AI-enabled functions requires computing resources far beyond the capabilities of traditional flight controllers for most practical AI applications
- **Option 1: Carry a single-board computer and AI accelerator on the drone**



AI Deployment (2/2)

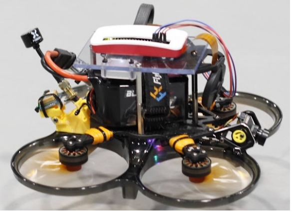
- **Option 2: Capture sensor data from the FPV goggles or transmit it to a ground station** (e.g., a laptop or Raspberry Pi 5 with AI HAT+) **and perform AI inference on the ground**
- Video grabbers are inexpensive (15–25 €)

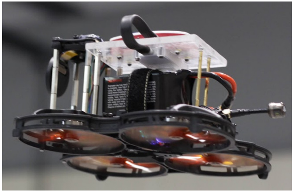
FPV goggles connected to a video grabber for processing the live video stream on a computer

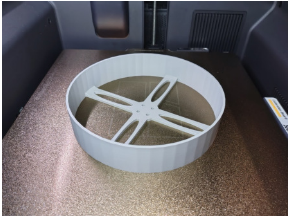


Transmission of the video stream (camera module connected to a Raspberry Pi) via Wi-Fi to a laptop for analysis (object detection)

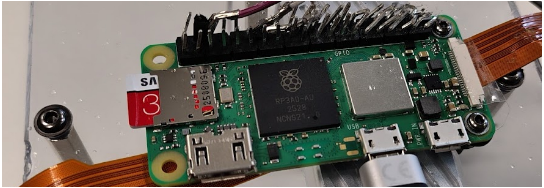
Lessons Learned from the 2nd Run (Winter 2025/26)





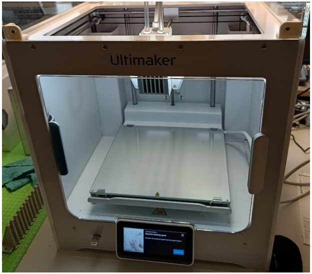


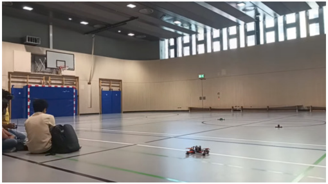
- Propeller guards allow safe indoor flight
- STM32F745-based FCs are ideal for autopilot applications
- Propellers with more blades provide better flight characteristics
- Propellers, batteries, VTX antennas and antenna connectors often need replacement
- Some hardware is worn out after a single semester (†)

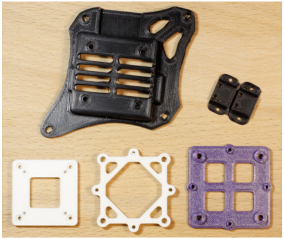


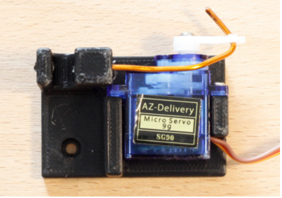
Essential Facilities and Laboratory Equipment

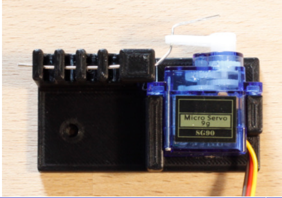
- Essential: a laboratory with soldering equipment and tools
- Space for teams to spread out components and work together
- Highly recommended: a sports hall for flight testing
- 3D printer and sufficient filament











Equipment per Team (3-4 Students) in Summer Term 2026

- Each group received a fully assembled and flight-ready FPV drone as well as the required components
- The goal of the project is the independent development, implementation, and evaluation of a practical drone AI application for the automated delivery of objects

Costs per Team in Summer Term 2026

Product	Weight [g]	Price [€]
CineWhoop Frame SpeedyBee Bee35 PRO 3.5	130	55
Flight Controller Flywoo GOKU GN745 AIO	15	70
Receiver Radiomaster XR4 Gemini Dual-Band	5	45
Motors Emax Eco II 2004 3-6S 3000KV	65	60
Propellers (min. 12) HQprop DT90mmx5	5	15
Video Transmitter SpeedyBee TX800 VTX	10	40
Video Antenna TrueRC Singularity 5.8GHz RHCP	5	20
GPS with Compass HGLRC M100-5883	8	20
Micro Servo (min. 2) 9g	10	5
Drop Mechanism (self-printed)	10	1
Camera RunCam Phoenix 2 Pro 1500TVL Analog	8	35
Battery (min. 3) Li-Ion 2500mAh 14.8V 12C	200	65
Raspberry Pi Zero 2 WH	10	20
Raspberry Pi Case	15	10
32GB microSD Card	1	10
Raspberry Pi AI Camera Module	6	80
Camera Module Case	8	5
Battery Eliminator Circuit 5V 3A Peak (min. 2)	4	10
MicroAir MTF-01P LiDAR and Optical Flow Sensor	10	30
Radiomaster GX12 ELRS Radio Transmitter		200
Skyzone Cobra X V4 FPV Goggles		325
18650 Batteries for Transmitter and Goggles (3x)		20
USB microSD Card Reader		5
SkyRC B6neo+ 240W Charger		50
USB-C Power Supply 27W (e.g. for the Charger)		15
Power bank 20000 mAh (backup power supply)		30
USB Audio/Video Grabber		20
USB UART Adapter (for the MicroAir MTF-01P)		5
USB (A+C) Cables, HDMI/MiniHDMI Cables		10
SpeedyBee Adapter V3 (Configuration Tool)		40
Aluminium Case (approx. 45x30x15 cm)		25
Vifly ShortSafer Smokestopper XT30/XT60		15
Screwdrivers, Screws, Connection Cables, etc.		30
Total	525	1386

- Components of one Drone: ≈ 430 €
- Gray rows indicate reusable equipment: ≈ 950 €

- This calculation excludes spare parts and laboratory equipment such as solder, flux and 3D printer filament

AI-Powered Drone Platform – Innovation for Accessible Research and Education

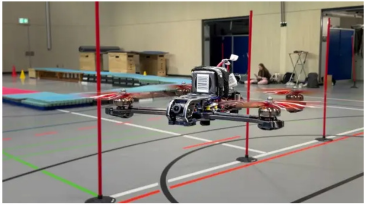
Research project (4/2025-12/2025) funded by the **Connectom** Networking and Innovation Fund of **hessian.AI** to develop practical guides for flexible, programmable and low-cost AI-enabled drones built from components that are reliably available on the market

- `github.com/christianbaun/aidrones`
- A bilingual handbook on the design, build and use of AI-enabled drones
- Based on previous AI drone courses, research projects and student theses
- The handbook is continuously being expanded and updated
- Feedback, suggestions and contributions are highly welcome
- The entire work is licensed under the Creative Commons license CC-BY-SA-4.0

heise online

Frankfurt University publishes manual with AI drone construction guides

Building AI drones yourself requires some experience. A manual from Frankfurt UAS facilitates such projects.



(Image: Frankfurt UAS)

Feb 19, 2026 at 11:42 am CET 2 min. read

By Oliver Bünte

Scientists at the Frankfurt University of Applied Sciences (Frankfurt UAS) have published a manual in German and English as part of their research and teaching activities in the field of drones with artificial intelligence (AI). In the manual, the researchers describe technical fundamentals and provide construction guides for AI drones. The manual is open source and available for download on GitHub.

The manual is intended for beginners in the world of AI drones and therefore does not claim to be exhaustive. Nevertheless, the manual is to be continuously developed to remain up-to-date, which is the goal of the project.

The book covers a variety of topics important for building AI drones. For example, it discusses the correct selection of hardware components such as sensors. Other topics include software, object recognition, autonomous navigation, and automatic object tracking. The purchase costs and thus the economic viability are also taken into account.

Practical Relevance and Conclusions

- **The project resulted in working AI drone prototypes, student projects and a publicly available handbook**
- AI drones are relevant for a wide range of applications
  - **Productivity**: Inventory management, predictive maintenance and defect detection
  - **Security**: Detection of intrusions, theft, natural hazards, vandalism. . .
  - **Logistics**: Rapid delivery of goods while bypassing conventional transport routes
- **AI drones belong in the curricula of Universities of Applied Sciences!**