“Hawkeye System-Hardware”

Advanced Gimbal-Based Object Tracking for Autonomous Drone Systems

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Technical University
of Applied Sciences
Würzburg-Schweinfurt

Project goal:

Building on last years successful project -our autonomous drone platform- we aim to implement advanced target tracking capabilities through precision gimbal systems. The platform should reliably track humans, vehicles, or objects even when temporarily obscured, enabling applications in **indoor navigation safety** and search and rescue operations.

Tasks:

1. **Design and build a custom gimbal system** for integration with our existing drone platform
2. **Perform extrinsic calibration** between the gimbal, drone frame, and camera systems to ensure precise tracking
3. **Implement real-time object detection** using YOLO on the Raspberry Pi 5 for target identification
4. **Develop stable visual servoing (control) algorithms** to maintain tracked objects centered in the camera frame
5. **Create persistence algorithms** that maintain target tracking during temporary occlusion events
6. **Design and implement custom mounting solutions** for specialized camera configurations (RGB+Thermal options)
7. **Test and optimize the system** in various real-world scenarios and environments

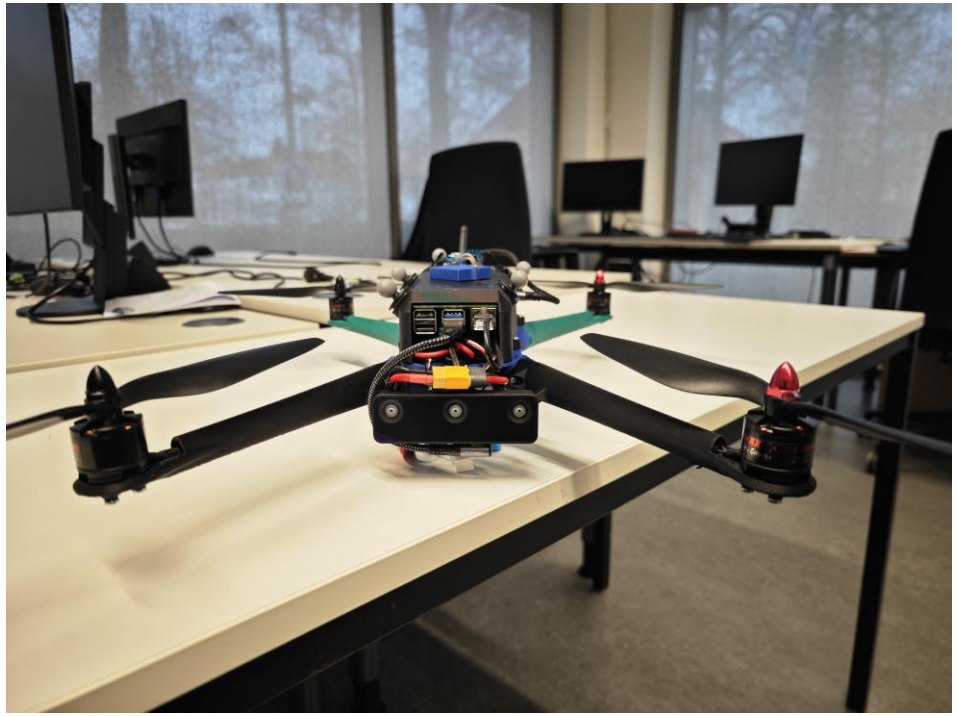

Figure 1: Custom Drone Platform Prototype

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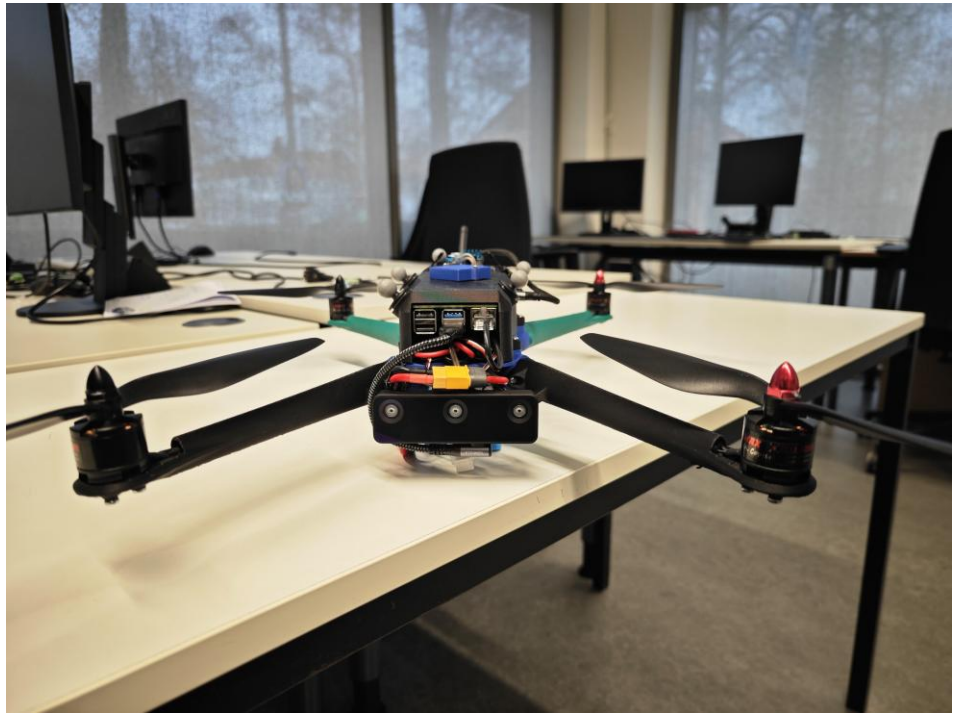
General Information:

- Meetings will be held every ~ 2 weeks.
- Weekly tasks → Feedback to me and/or Prof. Willert
- Autodesk Fusion 360 for Design: Please obtain a student license (free).
- Fusion 360 Team is set up. This is where we work.
- Maintain proper history for designs.
- Do not touch existing components.
- Document your findings and work. (also useful for the quarterly attestations)
- Google Drive Document „Arcane Knowledge on Gimbals“



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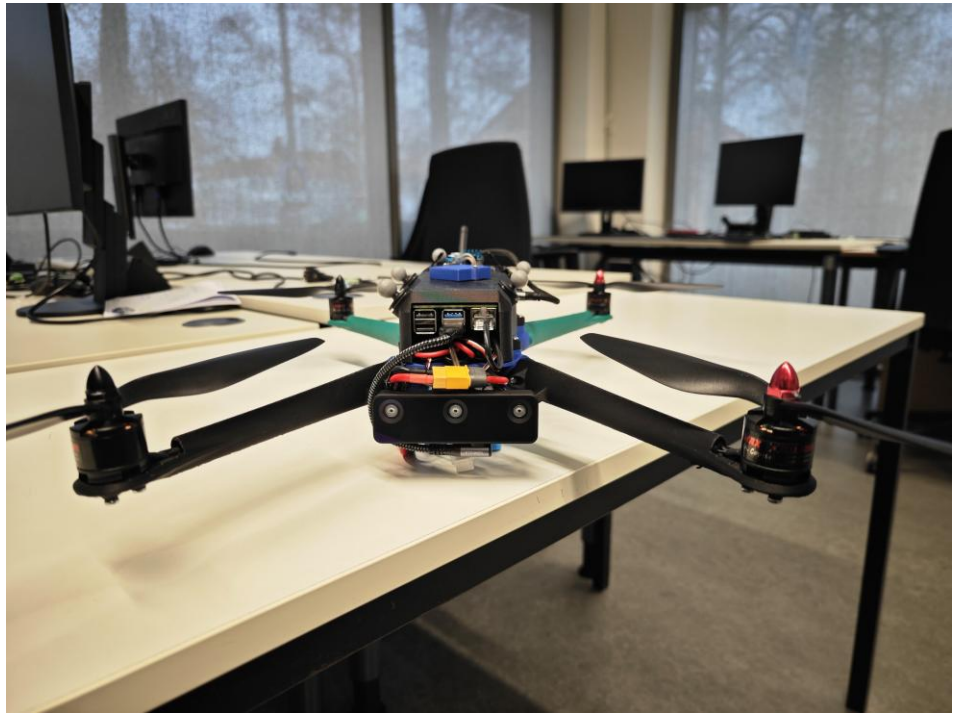
KW13/14 Weekly Tasks:

1. **Overview of common gimbal designs** with associated advantages and disadvantages.
2. **Survey of motors used in gimbal systems** including characteristics relevant to UAV use.
3. **Overview of control interfaces of existing gimbals** and required protocols for integration (I^2C, UART, CAN, etc.).
4. **Overview of stabilization techniques** used in gimbals (active and passive) and their effectiveness in drone applications.
5. **(Optional)Survey of integration constraints** when mounting gimbals on UAVs (size, weight, power, wiring, EMI).



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“Hawkeye System-Software”

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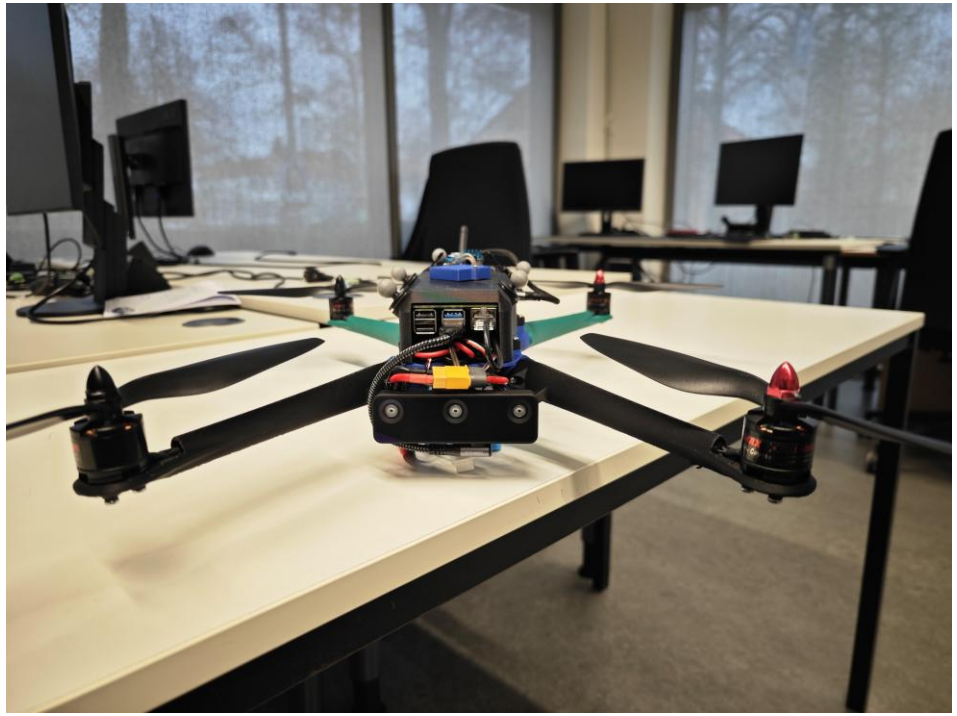

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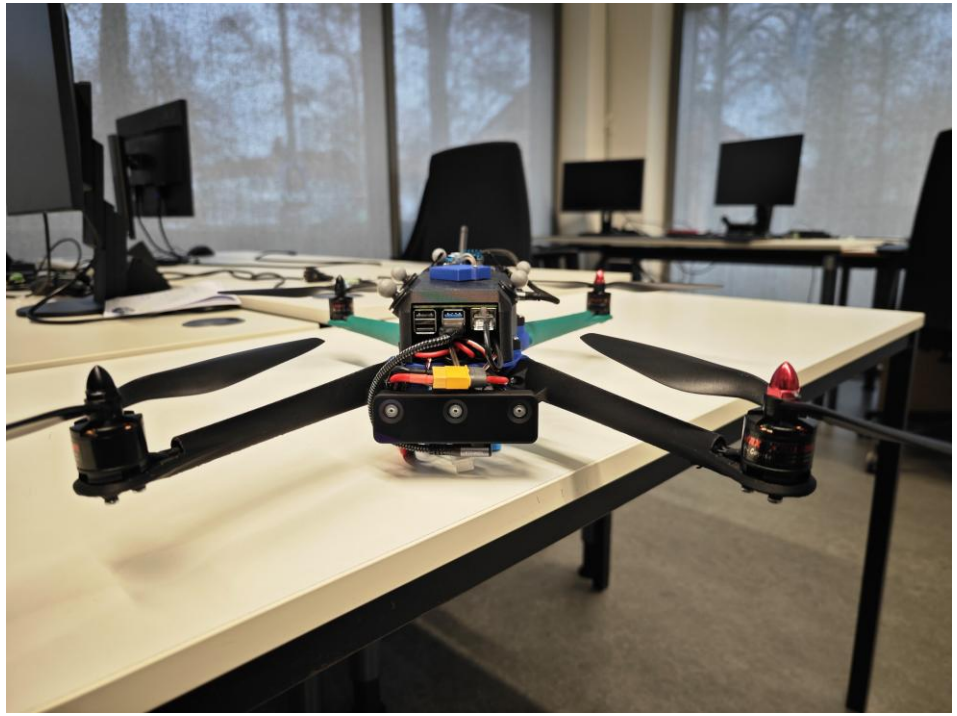

Figure 1: Custom Drone Platform Prototype

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KW13/14 Weekly Tasks:

1. **Overview of camera-based human tracking methods in close-range scenarios** and comparison based on relevant criteria.
2. **Survey of existing methods for thermal-RGB fusion** with focus on relevant advantages and limitations.
3. **Overview of stabilization techniques** used in gimbals (active and passive) and their effectiveness in drone applications.

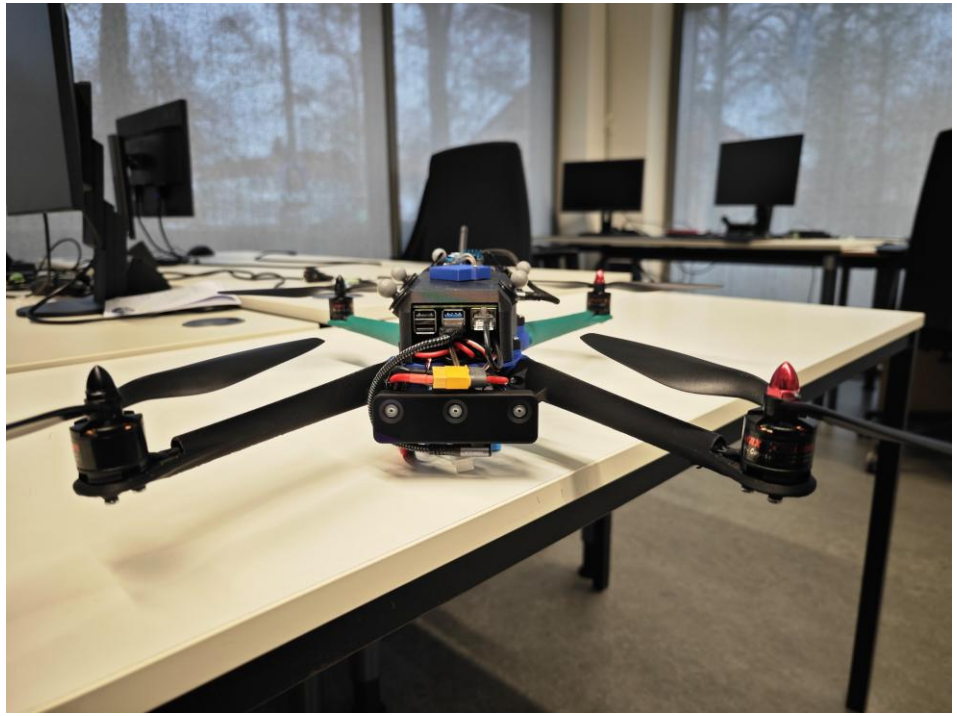

Figure 1: Custom Drone Platform Prototype

Autonomous and Safe Sensor Calibration

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Requirements / Skills:

- Programming skills (C++)
- CAD Modelling
- Hardware Integration

- **Number of Project members:** 3-5

- **Work location:** Depends on the Project Stage, 70% Campus 30% Home
- **Language:** English

- **Supervisor:** Prof. Dr. -Ing. Volker Willert
- **Support :** Julius Korch, Msuega Iorpenda
- **Contact:** julius.korch@study.thws.de
  iorpenda.msuega.doktoranden@thws.de

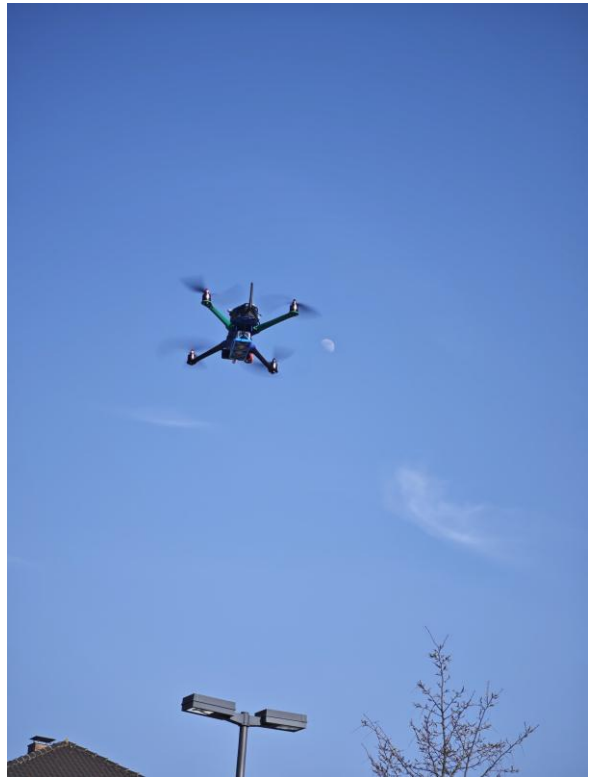

Figure 2: Drone in auto Flight

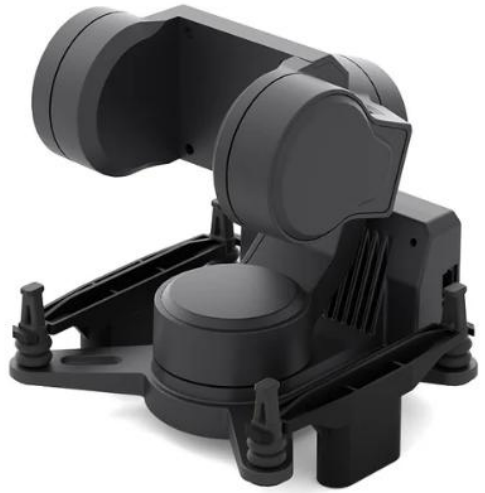

Figure 3: Example GM3 Gimbal